



NEW ZEALAND



EDICT OF GOVERNMENT



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AS-NZS 3500-4 (2003) (English): Plumbing and drainage - Part 4: Heated water services [By Authority of New South Wales Code of Practice - Plumbing and Drainage]

*We will sell to no man,
we will not deny or defer to any man either justice or right.*

Magna Carta—Tūtohunga Nui

*Kore rawa e hoko ki te tangata, e kore e whakakāhoretia,
e tautuku rānei te tangata ki te ture, tika ranei.*



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Australian/New Zealand Standard™

Plumbing and drainage

Part 4: Heated water services

AS/NZS 3500.4:2003

AS/NZS 3500.4:2003

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WS-014, National Plumbing and Drainage. It was approved on behalf of the Council of Standards Australia on 19 August 2003 and on behalf of the Council of Standards New Zealand on 22 August 2003.

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The following are represented on Committee WS-014:

	ACT Department of Urban Services
	Association of Hydraulic Services Consultants Australia
	Australian Building Codes Board
	Australian Industry Group
	Brisbane Water
	Building Industry Authority NZ
	Building Officials Institute of New Zealand
	Building Research Association of New Zealand
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	Gas Appliance Manufacturers Association of Australia
	Housing Industry Association
	Institute of Plumbing Australia
	Master Builders Australia
	Master Plumbers, Gasfitters and Drainlayers New Zealand
	National Association Sanitary Plumbing and Drainage Contractors
A2	National Fire Industry Association
	New Zealand Water and Waste Association
	Plastics Industry Pipe Association of Australia
	Plumbers, Gasfitters and Drainlayers Board
A2	Plumbing Products Industry Group
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Australian/New Zealand Standard™

Plumbing and drainage

Part 4: Heated water services

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WS-014, National Plumbing and Drainage Code, to supersede AS/NZS 3500.4.2:1997.

This Standard incorporates Amendment No. 1 (November 2005) and Amendment No. 2 (December 2010). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide installers with solutions to comply with—

- (a) the Plumbing Code of Australia (PCA), and
- (b) the New Zealand Building Code (Clause G12 Water Supplies).

This revision of this Standard has been developed to complement the Plumbing Code of Australia and incorporates amendments and additions arising from industry requirements and the energy efficiency provisions.

This Standard is part of a series of Standards for plumbing and drainage, as follows:

AS/NZS

3500	Plumbing and drainage
3500.0	Part 0: Glossary of terms
3500.1	Part 1: Water services
3500.2	Part 2: Sanitary plumbing and drainage
3500.3	Part 3: Stormwater drainage
3500.4	Part 4: Heated water services (this Standard)
3500.5	Part 5: Domestic installations

This revision includes following changes:

- (a) Alignment with the requirements of the Plumbing Code of Australia.
- (b) A revision of the materials used in plumbing.
- (c) Incorporation of Amendment 1 on energy efficiency.
- (d) Energy region maps for each state of Australia.
- (e) PL/1 rulings 2002 numbers 1 to 35.

A2 | This Standard is to be read in conjunction with the Plumbing Code of Australia (PCA) in Australia and the NZ Building Code in New Zealand.

A1 | The energy efficiency requirements contained in this edition are, in small part, Australia's response to concerns and responsibilities to global warming. It is one step in the commitment towards greenhouse gas reduction for Australia in response to the Kyoto Agreement.

Where alternative Australian or New Zealand standards are referenced (e.g., AS 1345 or NZS 5807 as appropriate) the Australian Standard shall be used for Australia and the New Zealand Standard shall be used for New Zealand.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

Statements expressed in mandatory terms in notes to figures and tables are deemed to be requirements of this Standard.

PROVISION FOR REVISION

This Standard necessarily deals with existing conditions, but is not intended to discourage innovation or to exclude materials, equipment and methods that may be developed in future. Revisions will be made from time to time in view of such developments and amendments to this edition will be made only when absolutely necessary.

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This Standard includes commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by 'C' preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

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Australian/New Zealand Standard

Plumbing and drainage

Part 4: Heated water services

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

- A2 | This Standard sets out the requirements for the design, installation and commissioning of heated water services using drinking water or rainwater or a combination thereof. It includes aspects of the installation from, and including, the valve(s) on the cold water inlet to any cold water storage tank or water heater and the downstream fixtures and fittings. It applies to new installations as well as alterations, additions and repairs to existing installations.

This Standard applies to the installation of the following types of water heaters (see Clause 5.2.1 or Clause 6.3.1):

(a) Storage water heaters with a rated delivery or capacity of up to 700 L per heater.

(b) Heat exchange water heaters.

NOTE: Electric heat exchange water heaters are defined in AS 1361, and other fuel sources are covered in the applicable standards e.g., AS/NZS 2712, AS 4552.

- A2 | (c) Instantaneous (continuous flow) water heaters.

(d) All authorized water heaters.

Illustrations used in this Standard are diagrammatic only and have been chosen without prejudice.

1.2 APPLICATION

1.2.1 Plumbing Code of Australia reference

- A1 | This Standard is referenced in Plumbing Code of Australia.

1.2.2 Building Code of Australia

This Standard may be used as a means of demonstrating compliance with the Requirement of Clause J7.2 of Volume One and Part F3.12.5 of Housing provisions of the Building Code of Australia.

This Standard will be referenced in the Building Code of Australia by way of BCA 2006 to be adopted on 1 May 2006.

1.2.3 New Zealand Building Code reference

This Standard may be used for compliance with the New Zealand Building Code, Clause G12, Water Supplies.

1.3 NORMATIVE REFERENCES

- A2 | The normative documents referenced in this Standard are listed in Appendix A.

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

1.4 DEFINITIONS

For the purpose of this Standard the definitions given in AS/NZS 3500.0 and the one below apply.

1.4.1 Container

The vessel, including fittings, in which the heated water is stored, sometimes referred to as a storage container, cylinder or tank.

1.5 PLASTICS ABBREVIATIONS

The following plastics abbreviations are used in this Standard:

ABS	Acrylonitrile butadiene styrene
GRP	Glass-filament-reinforced thermosetting plastic
HDPE	High density polyethylene
PP	Polypropylene
PP-R	Polypropylene random copolymer
PB	Polybutylene
PE	Polyethylene
PE-X	Cross-linked polyethylene
PVC-C	Chlorinated polyvinyl chloride
PVC-U	Unplasticized polyvinyl chloride
PVC-M	Modified polyvinyl chloride
PVC-O	Oriented polyvinyl chloride

1.6 WATER QUALITY

Water quality can have a significant effect on the performance and life of water heaters and other items forming part of, or connected to, the heated water system.

Information on quality of the reticulated water should be available from the network utility operator. Where there is doubt about the suitability of a product for connection to the available water supply, advice about suitability shall be sought from the manufacturer. The manufacturer may request a water sample or analysis, which shall be in accordance with Appendix B.

Cl.6 Where rainwater is used in heated water systems, it is particularly important consumers are made aware of the advice from en—Health (see the document 'Guidance on Use of Rainwater Tanks', published on the en—Health website at enhealth.nphp.gov.au) and the manufacturers of items forming part of, or connected to, the heated water system.

1.7 EQUIVALENT PIPE SIZES

Where the nominal size of a pipe or fitting is specified in this Standard, an equivalent pipe size, appropriate to the material being used, shall be selected from Table 1.1.

1.8 VELOCITY REQUIREMENTS

The maximum water velocity in piping shall be 3.0 m/s.

1.9 WATER TEMPERATURE

1.9.1 Storage temperature

A2 | Heated water shall be stored and delivered under conditions that avoid the likelihood of the growth of *Legionella* bacteria. This may be achieved by—

- (a) storing heated water at a temperature above 60°C; or
- (b) installing a water heater certified to AS 3498 (Australia only).

NOTE: In Australia, AS 5200.000 requires that water heaters and hot water storage tanks comply with AS 3498.

1.9.2 Sanitary fixtures delivery temperature

A2 | All new heated water installations shall deliver heated water not exceeding—

- (a) 45°C at the outlet of sanitary fixtures used primarily for personal hygiene purposes for the aged, the sick, children or people with disabilities in healthcare and aged care buildings, early childhood centres, primary and secondary schools and nursing homes or similar facilities for the aged, the sick, children or people with disabilities; and
- (b) 50°C at the outlet of sanitary fixtures used primarily for personal hygiene purposes for all other situations.

NOTES:

- 1 Sanitary fixtures used for personal hygiene purposes include showers, baths, handbasins and bidets.
- 2 Temperature limits are required to minimize the risk of scalding. At greatest risk from scalding are children, the aged, the sick and people with disabilities, particularly those in institutional care.
- 3 For Australia, 'healthcare building' means a building whose occupants or patients undergoing medical treatment generally need physical assistance to evacuate the building during an emergency and includes—
 - (a) a public or private hospital;
 - (b) a nursing home or similar facility for sick or disabled persons needing full-time care; or
 - (c) a clinic, day surgery or procedure unit where the effects of the predominant treatment administered involve patients becoming non-ambulatory and requiring supervised medical care on the premises for some time after the treatment.
- 4 For Australia, 'aged care building' means a building for residential accommodation of aged persons who, due to varying degrees of incapacity associated with the ageing process, are provided with personal care services and 24 h staff assistance to evacuate the building during an emergency.

1.9.3 Acceptable solutions for control of delivery temperatures

The following shall apply:

- A2 | (a) The installation is deemed to comply with Clause 1.9.2(a) if all sanitary fixtures used primarily for personal hygiene purposes are supplied from a thermostatic mixing valve complying with AS 4032.1 and adjusted to an outlet temperature not exceeding 45°C at each outlet supplied from the thermostatic mixing valve.
- (b) The installation is deemed to comply with Clause 1.9.2(b) if all sanitary fixtures used primarily for personal hygiene purposes are supplied from—
 - A2 | (i) a thermostatic mixing valve complying with AS 4032.1 and adjusted to an outlet temperature not exceeding 50°C at each outlet supplied from the thermostatic mixing valve;

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(ii) a tempering valve complying with AS 4032.2 and adjusted to an outlet temperature not exceeding 50°C at each outlet supplied from the tempering valve; or

(iii) a water heater complying with AS 3498 and marked with the following:

**THIS APPLIANCE DELIVERS WATER NOT EXCEEDING 50°C
IN ACCORDANCE WITH AS 3498**

NOTES:

- 1 Temperature control devices require routine maintenance and performance testing. Information on maintenance can be found in AS 4032.2.
- 2 It is the property owner's responsibility to ensure that the routine maintenance is carried out.

**TABLE 1.1
EQUIVALENT PIPE SIZES GUIDE**

Specified nominal size DN	Acceptable equivalent size						
	Copper		Stainless steel	PE-X	PB	PP-R	PEX AL P ETC
	AS 1432	NZS 3501					
10	10	10	10	12	15*	12	10
15	15	15	15	16	18	16	15
18	18	—	18	20	20	20	20
20	20	20	20	25	22	25	20
25	25	25	25	32	28	32	25
32	32	32	32	40	40	40	32
40	40	40	40	50	50	50	50
50	50	50	50	63	63	63	—

* No size smaller than 15 in AS/NZS 2642.2.

NOTE: Alternative sizes may be used providing they meet the performance requirements of this Standard.

SECTION 2 MATERIALS AND PRODUCTS

2.1 SCOPE OF SECTION

This Section specifies the requirements for materials and products to be used in heated water services.

2.2 AUTHORIZATION

A2

Materials and products used in Australia for plumbing and drainage installations shall have been authorized in accordance with the Plumbing Code of Australia. Product authorization is not required in New Zealand.

The Plumbing Code of Australia (PCA) requires material and product types listed in Table A.2.1 be certified under the WaterMark Scheme. A schedule of materials and products requiring authorization and relevant specifications is included in AS 5200.000.

NOTE: A database of authorized products is available from www.watermarkstandards.org.au

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2.3 SELECTION AND USE OF MATERIALS AND PRODUCTS

Materials and products for use in contact with heated water shall comply with the hot water exposure requirements of AS/NZS 4020. Linings and coatings shall comply with AS/NZS 4020 at a surface area to volume ratio less than that nominated in the compliance report.

The products and materials used shall be selected to ensure that they are fit for their intended purpose.

The pipes and fittings shall be selected from those listed in Appendix C, unless otherwise approved by the authority having jurisdiction.

Factors to be taken into account include but are not limited to—

- (a) the type of usage likely to occur;
- (b) the nature and temperature of the water to be conveyed and the risk of corrosion, degradation and leaching;
- (c) the nature of the environment, the ground and the possibility of chemical attack therefrom;
- (d) the physical and chemical characteristics of the materials and products;
- (e) compatibility of materials and products;
- (f) the pressure rating of pipes and fittings at elevated temperatures; and
- (g) accessibility for inspection, service, repair and replacement.

NOTES:

- 1 Information on some of the items listed above may be obtainable from the manufacturer or supplier of the product or material.
- 2 Plastics pipe and fittings are classified according to nominal working pressure (PN) at 20°C.

2.4 PIPES AND FITTINGS

2.4.1 General

A2 | The following limitations shall apply to the use of pipes and fittings for heated water services:

- (a) Pipes and fittings—
 - (i) up to and including DN 100, shall have a maximum allowable operating pressure of at least 1.0 MPa at 60°C; and
 - (ii) larger than DN 100, shall be selected to accommodate the nominated operating pressure and temperature for the system.
- (b) Bends in pipes shall be free from wrinkling and flattening.
- (c) Semi-flexible connectors and braided flexible hoses shall only be used above surface level and in accessible locations.
- (d) Pipes and fittings shall be protected from excessive ambient heat.

NOTE: Limitations on the use of pipes and fittings should take into consideration the manufacturer's installation specifications, provided they do not contradict the requirements of this Standard.

2.4.2 Metallic pipes and fittings

Metallic pipes and fittings shall comply with the following:

- (a) Fittings used in conjunction with Stainless steel (SS) shall be either copper alloy compression type and be dezincification resistant (DR) or SS capillary type manufactured from grade 304 or 316 complying with ASTM A 268/268M.
- A1 | (b) Copper and copper alloy pipes and fittings shall be installed in accordance with the installation requirements of AS 4809.

2.4.3 Plastics pipes and fittings

Plastics pipes and fittings shall comply with the following:

- (a) Plastic pipes shall be of the classes listed in Appendix C.
- (b) Where subject to direct sunlight, plastics pipes and fittings shall be installed in accordance with the specific product installation Standard or manufacturer's recommendations.
- (c) Plastics pipes and fittings shall not be used between the isolation valve and the inlet to a water heater or within 1 m of the outlet of a water heater except, where a water heater is fitted with a temperature control valve, plastics pipe and fittings may be used immediately downstream of the temperature control valve.
- (d) Plastics pipes shall not be used to support isolation valves, non-return valves and equipment used to connect water heaters.
- A2 | (e) Plastics pipes and fittings shall not be used between a solar collector and a heated water container, unless supplied by the manufacturer as an integral component of the solar water heater system.
- (f) Plastics pipes and fittings shall not be used between an uncontrolled heat source and a heated water tank.
- (g) Plastics pipes and fittings shall not be used for the drain lines from temperature pressure-relief valves.

A1

2.5 'Text deleted'**2.6 SAFE TRAY AND SAFE WASTE MATERIALS****2.6.1 Safe tray**

Safe trays shall be fabricated from materials not inferior, under the conditions of use, to 0.60 mm thick galvanized steel sheet complying with AS 1397 and having a minimal nominal zinc coating mass of 275 g/m².

2.6.2 Safe wastes

Safe waste pipes from safe trays shall be fabricated from the following materials:

- (a) PVC-U complying with AS/NZS 1260.
- (b) Galvanized steel pipe complying with AS 1074 or NZS/BS 3601.
- (c) Seamless copper pipe (min. 0.9 mm thickness) complying with AS 1432 or NZS 3501.
- (d) Sheet steel (min. 0.6 mm thickness) complying with AS 1397.

2.7 JOINTS**2.7.1 Flanged joints**

Flanged joints shall comply with—

- (a) AS/NZS 2280 and AS/NZS 2544 for ductile iron and grey cast iron; or
- (b) AS 2129 or AS/NZS 4331 or AS 4087 and be appropriate for the test pressure requirements of Section 13.

2.7.2 Elastomeric seals

Elastomeric seals materials shall comply with AS 1646.1 and AS 1646.2 or AS 1646.3, as appropriate.

Where an elastomeric seal gasket is normally provided in the line or in a fitting, it shall not be replaced with mastic or sealant compounds.

2.7.3 Shouldered or grooved joints

Shouldered or grooved joints shall comply with the manufacturer's specification relevant to the pipe material being used. See AS/NZS 3500.1 for the use of shouldered or grooved joints below ground.

2.7.4 Silver brazing alloy**2.7.4.1 Copper and copper alloys**

Silver brazing alloys for capillary jointing of copper and copper alloy pipes and fittings shall comply with the requirements for silver or copper phosphorous brazing alloys of AS 1167.1 and contain a minimum of 1.8% silver and a maximum of 0.05% cadmium.

2.7.4.2 Stainless steels

Silver brazing alloys for capillary jointing of stainless steel pipes and fittings shall comply with the requirements of AS 1167.1 and contain a minimum of 38% silver and a maximum of 0.05% cadmium.

2.7.5 Soft solders

Soft solder shall—

- (a) not contain more than 0.1% lead by weight;
- (b) only be used for jointing copper or copper alloy pipes to capillary fittings of the long engagement type complying with AS 3688; and

- (c) not be used with coiled annealed pipes.

NOTE: The chemical composition of water in some areas may preclude the use of soft solder joints.

2.7.6 Filler rods for stainless steel joints

Joints in stainless steel pipework larger than DN 25 shall be made using filler rods of low carbon stainless steel not greater than 2 mm in diameter and complying with AS/NZS 1167.2.

2.8 CONCRETE AND MORTAR

2.8.1 Concrete mix

Ready-mixed concrete shall comply with AS 1379 and shall have a minimum characteristic compressive strength of 20 MPa as defined in AS 3600 or NZS 3109 and NZS 3124.

Site-mixed concrete shall consist of cement, fine aggregate and coarse aggregate, all measured by volume, properly mixed with sufficient water added to render the mix workable. It shall have a minimum characteristic compressive strength of 20 MPa.

2.8.2 Cement mortar

Cement mortar shall consist of one part cement and two parts of fine aggregate measured by volume, properly mixed with the minimum amount of water necessary to render the mix workable.

NOTE: For bedding pipes, a mixture consisting of one part cement to four parts of fine aggregate may be used.

Cement mortar that has been mixed and left standing for more than 1 h shall not be used.

2.8.3 Chemical admixtures

Chemical admixtures used in concrete shall comply with AS 1478.1.

2.8.4 Water for concrete and mortar

Water used for mixing concrete and cement mortar shall be free from impurities that are harmful to the mixture, the reinforcement, or any other items embedded within the concrete or mortar.

2.8.5 Steel reinforcement

Steel reinforcing materials used in concrete structures shall comply with AS/NZS 4671.

2.9 MISCELLANEOUS MATERIALS

2.9.1 Timber

Timber exposed to the weather shall be of durability Class 2 complying with AS/NZS 2878, NZS 3631 or shall be adequately treated in accordance with AS 1604 or NZS 3640.

2.9.2 External protective coatings

External coatings used for protection against corrosion of pipelines buried in corrosive areas shall—

- (a) be impervious to the passage of moisture;
- (b) be resistant to the external corrosive environment;
- (c) be resistant to abrasion by the surrounding fill; and
- (d) not contain any material that could cause corrosion to the underlying pipes or fittings.

NOTE: Polyethylene sleeving used to protect underground pipelines may require additional protection if installed in rock or stony ground.

SECTION 3 CROSS-CONNECTION AND BACKFLOW PREVENTION AND THERMOSTATIC MIXING VALVES

3.1 SCOPE OF SECTION

This Section sets out the requirements for the installation of backflow prevention devices and thermostatic mixing valves.

3.2 CROSS-CONNECTION CONTROL AND BACKFLOW PREVENTION

Cross-connection controls and backflow prevention devices shall be installed in accordance with AS/NZS 3500.1.

3.3 THERMOSTATIC MIXING VALVES

A2 Each thermostatic mixing valve shall be installed in accordance with the relevant requirements of this Standard and the following:

- (a) The manufacturer's installation instructions, provided they comply with this Standard.

NOTE: AS 4032.1 requires that each thermostatic mixing valve be supplied with comprehensive installation instructions.

- (b) Each thermostatic mixing valve shall have an isolating stop tap/valve, line strainer and cross-flow prevention device (non-return) valve fitted to the heated and cold water supply lines as shown in Figure 3.1.

NOTE: These devices may be fitted separately from the thermostatic mixing valve or as an integral part of the valve.

- (c) Independent ancillary items, e.g., isolating assemblies, shall comply with the relevant Australian Standard. Integral stop tap/valves and cross-flow valves shall comply with AS 4032.1.

A2 (d) **'Text deleted'**

- (e) There shall be no branch line off-take between a non-integral isolating valve and the inlet to the thermostatic mixing valve except in multiple installations (see Item (g)).

- (f) Thermostatic mixing valves shall be adequately supported, independent of all piping.

- (g) Where multiple installations of thermostatic mixing valves are located in the same area, then a stop/tap valve, line strainer and non-return valve may control each of the hot and cold water supplies to more than one thermostatic mixing valve, provided each of the individual thermostatic mixing valves are controlled by an isolating stop tap/valve and installed with a cross-flow non-return valve.

- (h) Each thermostatic mixing valve and each associated valve, pressure control or temperature control shall be readily accessible.

- (i) The nominal size of the connecting piping and associated valves shall be not less than the nominal size of the thermostatic mixing valve. For sizing of pipes, see AS/NZS 3500.1.

- (j) The flushing specified in Clause 11.2 shall be undertaken—

- (i) prior to the installation of the thermostatic mixing valve(s); or

- (ii) after the installation of the thermostatic mixing valve(s), provided each line-strainer integral and non-integral isolating valve and each thermostatic element/sensor is removed and cleaned and replaced after the flushing operation is completed.

A2

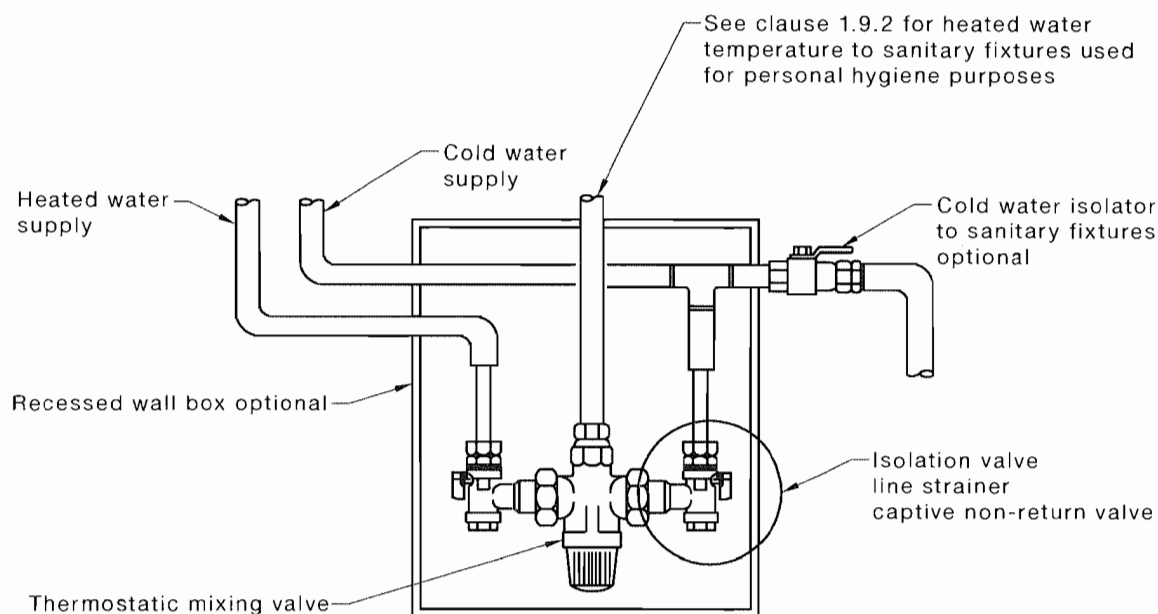


FIGURE 3.1 TYPICAL ISOLATING ASSEMBLY FOR WATER SUPPLIES TO THERMOSTATIC MIXING VALVE

SECTION 4 INSTALLATION OF COLD AND HEATED WATER PIPING AND CONTROLS

4.1 SCOPE OF SECTION

This Section sets out the requirements for the installation of pipes, fittings, cold water storage tanks and apparatus used to supply water to and from a water heater.

4.2 ELECTRICAL SAFETY PRECAUTIONS AND EARTHING

A2

Safety precautions need to be observed when cutting into pipework or disconnecting water meters, fittings and devices on pipework. There have been fatalities and injuries that have been attributed to water services carrying an electrical current.

Where existing metallic service pipework is to be replaced in part or in its entirety by plastics pipe or other non-metallic fittings or couplings, the work should not commence until the earthing requirements have been checked by an electrical contractor and modified, if necessary.

4.3 PROXIMITY TO ELECTRICAL CABLES AND GAS PIPES

4.3.1 General

Where electrical conduits, wires, cables or consumer gas pipes, drains and other services are in existence, pipes shall be installed in accordance with the requirements of Clause 4.3.2.

4.3.2 Electrical cables, gas pipes and other services

4.3.2.1 Above- and below-ground pipework

Above- and below-ground pipework associated with heated water services shall be installed so that—

- (a) no potential safety hazard is created when in close proximity to other services; and
- (b) access for maintenance and potential branch insertions is not impaired by other services.

4.3.2.2 Above-ground pipework

Above-ground pipework associated with heated water services shall not be installed within 100 mm of electrical cables, gas pipes or other services.

4.3.2.3 Below ground—Electrical cables and gas pipes

The separation between pipework associated with heated water services and electrical cables and gas pipes shall be maintained at 300 mm. Where this separation cannot be achieved, the distance may be reduced to not less than 100 mm provided that the electrical cables or gas pipes are marked and mechanically protected along their length within the exclusion zone.

4.3.2.4 Below ground—Communications services

The separation between pipework associated with heated water services and communication services shall be maintained at 100 mm.

4.3.2.5 Below ground—Crossover

Any below-ground crossover of pipework associated with heated water service shall—

- (a) cross at an angle of not less than 45°;

- (b) have a vertical separation of not less than 100 mm; and
- (c) be marked and mechanically protected.

4.4 METHODS OF JOINTING

4.4.1 General

Jointing of pipework associated with heated water services shall be in accordance with the following:

- (a) *Removal of burr* The burr formed in cutting any pipe shall be removed.
- (b) *Joints requiring use of heat* Care shall be taken so that pipes or fittings are not damaged by the application of excessive heat.
- (c) *Use of fittings* Where straight sections of pipe of different diameter are to be joined, such increase or reduction in size shall be made by a fitting.
- (d) *Crimping* Crimping, to reduce a larger diameter pipe when joining to a smaller diameter pipe, shall not be permitted.
- (e) *Jointing of copper or stainless steel pipes* Copper or stainless steel water service pipes of different diameter shall not be permitted to be joined by filling the annular space using a filler rod.
- (f) *Fabricated fittings* Sockets and tees may be fabricated from copper, copper alloy or stainless steel pipes using tools specifically designed for such purposes and shall then be silver brazed.

Tees in copper shall not be fabricated from pipe of thickness less than Type C (AS 1432).

4.4.2 Threading

Threads shall comply with the relevant Standard for the materials to be joined and be sealed with an appropriate jointing medium.

4.4.3 Compression-type fittings

Compression fittings shall comply with AS 3688 or AS/NZS 4129. Plastic nuts shall not be used to connect any pipe to a cold water storage tank that supplies water to a water heater.

4.4.4 Capillary fittings

Capillary fittings complying with AS 3688 may be used to join pipes.

4.4.5 Silver brazing

4.4.5.1 Joints

A compatible flux shall be used when making joints.

4.4.5.2 Taps and valves

Silver brazing shall not be used as a means of jointing taps or valves to pipes larger than DN 20. To prevent damage, the tap assembly and jumper valve shall be removed from the body of taps and valves prior to silver brazing.

4.4.6 Soft soldering

A compatible flux shall be used when making joints.

NOTE: The chemical composition of the water in some areas may preclude the use of soft solder joints.

4.4.7 Flanged joints

Flanged joints shall be appropriate for the test pressure requirements described in Section 9 and shall be attached to the pipe by the following means:

- (a) Silver brazing in accordance with Clause 2.7.4 for copper alloy to copper or copper alloy pipes or fittings.
- (b) Set screws for cast iron pipes and fittings.
- (c) For stainless steel pipes larger than DN 25, flanged joints fabricated by rolling or welding to the pipe a stub flange of the same gauge and wall thickness as the pipe, having a diameter conforming to dimensions 'F' in AS 2129. A mild steel back-up flange complying with AS 2129 shall be fitted, and a gasket, not less than 3 mm thick, shall be inserted.

Flange joints below ground shall be protected against corrosion in accordance with Clause 4.8.

4.4.8 Shouldered or grooved joints

Shouldered or grooved joints may be used above or below ground.

Where used below ground, the joints shall be—

- (a) manufactured in stainless steel in accordance with ASTM A268/A268M or copper tubes in accordance with AS 1432;
- (b) protected against corrosion with each assembled copper joint protected with an approved petrolatum based wrapping system; and
- (c) external to a building and not under concrete.

4.4.9 Jointing of stainless steel pipe and fittings

4.4.9.1 Jointing of piping, up to and including DN25

Joints not larger than DN 25 shall be made by using mechanically jointed compression fittings Type 1 or 2 complying with AS 3688 or using silver brazed stainless steel capillary joints. Silver brazing alloys shall comply with Clause 2.7.4.2.

4.4.9.2 Jointing of piping larger than DN 25

Joints in stainless steel piping larger than DN 25 shall be either—

- (a) butt welded using a tungsten inert gas (TIG) argon arc method and—
 - (i) have a gap not greater than 0.5 mm between the abutting pipe ends to be joined;
 - (ii) have inserted a back-up ring 6 mm long, made from the parent pipe, to straddle the joint of pipes with a wall thickness less than 1.2 mm;
 - (iii) use a low carbon stainless steel type filler rod not greater than 2 mm in diameter; and
 - (iv) be tack-welded in not less than four spots around the circumference, prior to welding the entire joint; or
- (b) have flanged joints, fabricated by rolling or welding to the pipe, a stub flange of the same wall thickness as the pipe, having a diameter conforming to dimension 'F' in AS 2129 or AS/NZS 4331, with mild steel back-up flange complying with AS 2129 or AS/NZS 4331 fitted and a gasket not less than 3 mm thick, inserted.

NOTE: Jointing should be carried out by suitably trained personnel.

4.5 SUPPORT AND FIXING ABOVE-GROUND

4.5.1 General

Water services installed above-ground shall be retained in position by brackets, clips or hangers.

4.5.2 Brackets, clips and hangers

Brackets, clips and hangers shall be—

- (a) formed from a suitable material compatible with the pipe;
- (b) securely attached to the building structure;
- (c) designed to withstand the applied loads;
- (d) protected against corrosion, where exposed to a corrosive environment;
- (e) of like material or lined with a non-abrasive, inert material for that section where contact with the piping may occur;
- (f) clamped securely to prevent movement, unless designed to allow for thermal movement;
- (g) restrained to prevent lateral movement; and
- (h) installed so that no movement can occur while a valve is being operated and that the weight of the valve is not transferred to the pipe.

4.5.3 Prohibited supports

The following methods of support shall not be used:

- (a) Pipes supported by brazing or welding short sections of any material to the pipe surface, nor by clamping, brazing or welding to adjacent pipes.
- (b) Brackets, clips and hangers incorporating PVC used in contact with stainless steel pipes.

TABLE 4.1
SPACING OF BRACKETS AND CLIPS

Nominal pipe size DN	Maximum spacing of brackets and clips, m		
	Copper, copper alloy and stainless steel pipes	PE-X, PB, PVC-C and PP-R PE/AL/PE PE-X/AL/PE-X pipes	
		Horizontal or graded pipes	Vertical pipes
10	1.50	0.50	1.00
15	1.50	0.60	1.20
16	—	0.60	1.20
18	1.50	0.60	1.20
20	1.50	0.70	1.40
22	—	0.70	1.40
25	2.00	0.75	1.50
32	2.50	0.85	1.70
40	2.50	0.90	1.80
50	3.00	1.05	2.10
63	—	1.10	2.20
65	3.00	1.20	2.40
75	—	1.30	2.60
80	3.00	1.35	2.70
90	3.00	1.40	2.80
100	3.00	1.50	3.00
110	—	1.50	3.00
125	3.00	1.70	3.40
140	—	1.70	3.40
150	3.00	2.00	4.00
160	—	2.00	4.00

NOTES:

- 1 Due to water pressure effects, additional brackets, clips or hangers (complying with Clause 4.5.2) may be required to prevent movement.
- 2 Where plastics pipes are supported by building structures, clips and brackets may be placed at larger intervals than above. Pipes in parallel pipe systems may be bundled together using non-metallic ties.

4.5.4 Spacing

Water services shall be supported and fixed at intervals, as given in Table 4.1.

4.5.5 Securing of pipes and fittings

Any pipe or fitting that may be subjected to strain or torsion shall be positively fastened against twisting or any other movement.

For heated water piping, the fixing shall be in such a manner as to permit movement due to thermal expansion and not to cause damage or corrosion to the pipe (see Clause 4.5.3(b)).

4.6 LOCATION OF PIPING

4.6.1 Concealed piping

4.6.1.1 Walls

Water services located in timber- or metal-framed walls of brick or veneer construction shall be installed in accordance with the following:

- (a) *Timber wall framework* Holes or notches made in timber studs and plates in walls shall be in accordance with the following:
 - (i) The maximum size and spacing of holes or notches and the like in studs shall be in accordance with Figure 4.1 and Table 4.2.
 - (ii) Where unlagged pipes are used, a collar of lagging material or a neutral cure silicone sealant shall be used to fill the annular space.
- (b) *Timber beams, bearers and joists* Holes or notches made in timber beams, bearers and joists in floors shall be in accordance with Figure 4.2
- (c) *Metal framework* Holes drilled in metal studs or plates shall be accurately sized to enable suitable grommets, lagging or a short sleeve of oversize pipe firmly secured in the framework, to be inserted around the pipe to ensure no direct contact between the pipe and framework but allowing free longitudinal movement of the pipe through the grommet, lagging or sleeve.

NOTE: Care should be taken to ensure that the air cavity moisture barrier within an external wall of any building is not bridged with pipe or pipe duct penetrations and porous pipe insulation materials. A clear air gap is required between the external wall and the pipe insulation material.

- (d) Pipes located in cavities shall be installed so as to prevent the transfer of moisture from the outer wall to the inner wall.

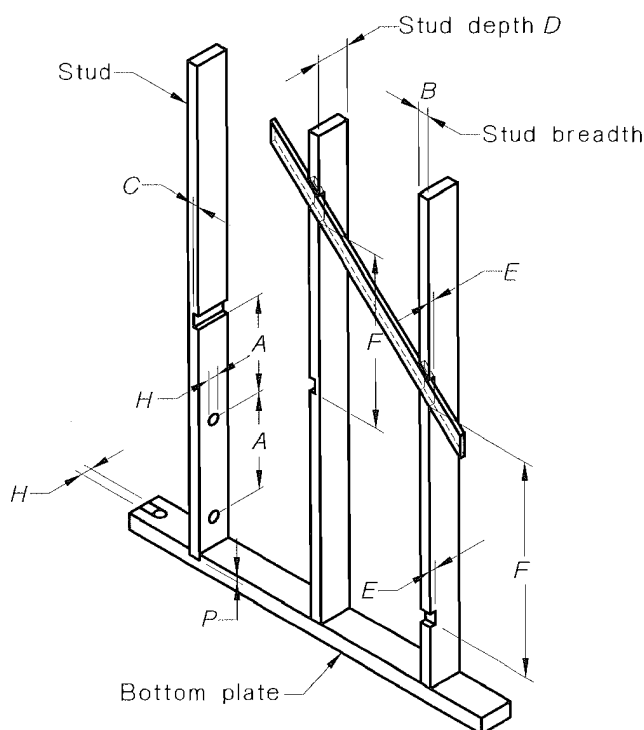
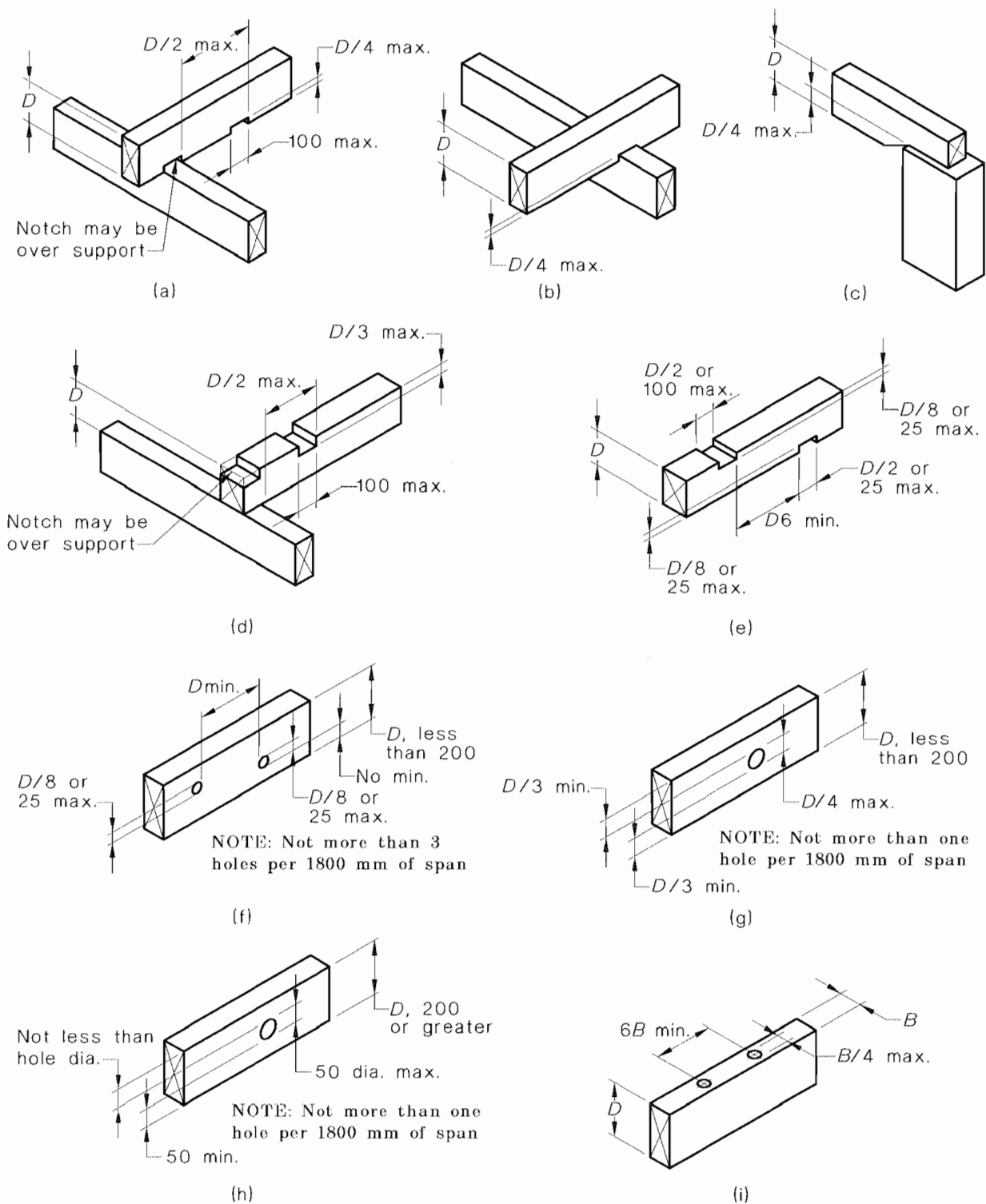


FIGURE 4.1 NOTCHING OF WALL STUDS

TABLE 4.2
HOLES AND NOTCHES IN STUDS AND PLATES

Symbol	Description	Limits	
		Notched	Not notched
<i>A</i>	Distance between holes and/or notches in stud breadth	Min. $3D$	Min. $3D$
<i>H</i>	Hole diameter (studs and plates)	Max. 25 mm (wide face only)	Max. 25 mm (wide face only)
<i>C</i>	Notch into stud breadth	Max. 10 mm	Max. 10 mm
<i>E</i>	Notch into stud depth	Max. 20 mm (for diagonal cut in bracing only) (see Note)	Not permitted (see Note)
<i>F</i>	Distance between notches in stud depth	Min. $12B$	N/A
<i>P</i>	Trenches in plates	3 mm max.	

NOTE: A horizontal line of notches up to 25 mm may be provided for the installation of baths.



DIMENSIONS IN MILLIMETRES

FIGURE 4.2 NOTCHES, CUTS AND HOLES IN BEAMS, BEARERS, JOISTS, RAFTERS

4.6.1.2 Chases, ducts or conduits

A2

Pipes located in chases, ducts, conduits or embedded in masonry or concrete shall be installed in accordance with the following:

- (a) Pipes and fittings in chases shall be continuously wrapped with an impermeable flexible material.

A2

- (b) Ducts shall be fitted with removable covers.
- (c) Conduits shall comply with the requirements of the Building Code of Australia or New Zealand Building Code, as applicable.
- (d) Adequate allowance shall be made for expansion and contraction in accordance with Clause 4.14.3.
- (e) Pipes shall not be embedded or cast into concrete structures.

4.6.1.3 Under concrete slabs

Water service pipes located beneath concrete slabs on ground level shall comply with the following:

- (a) Pipes shall be insulated in accordance with Clause 8.2, laid in a narrow trench on a bed of sand or fine-grained soil, placed and compacted in a manner that will not damage the piping or insulation. There shall be a minimum distance of 75 mm between the pipe and the underside of the slab.
- (b) Pipe ends shall be crimped or capped prior to pouring of the concrete and measures shall be taken to protect the exposed pipe from damage.
- (c) Any piping that penetrates the slab shall be at right angles to the surface of the slab and shall be lagged with an impermeable, flexible plastic material of not less than 6 mm thickness for the full depth of the slab penetration.
- (d) Soft-soldered joints shall not be permitted.
- (e) The number of joints shall be kept to a minimum.

4.6.2 Protection during building construction

Care shall be taken to ensure that the pipes are not damaged during normal building activities. Concealed pipework shall be maintained under normal water pressure while subsequent building operations are being carried out, which could cause damage to the pipes. The service shall be flushed with clean water at regular intervals until the building is occupied.

4.6.3 Floor or roof penetrations

Any suspended floor or roof penetration shall be rendered waterproof such as to allow for expansion.

4.6.4 Provision for movement of encased piping

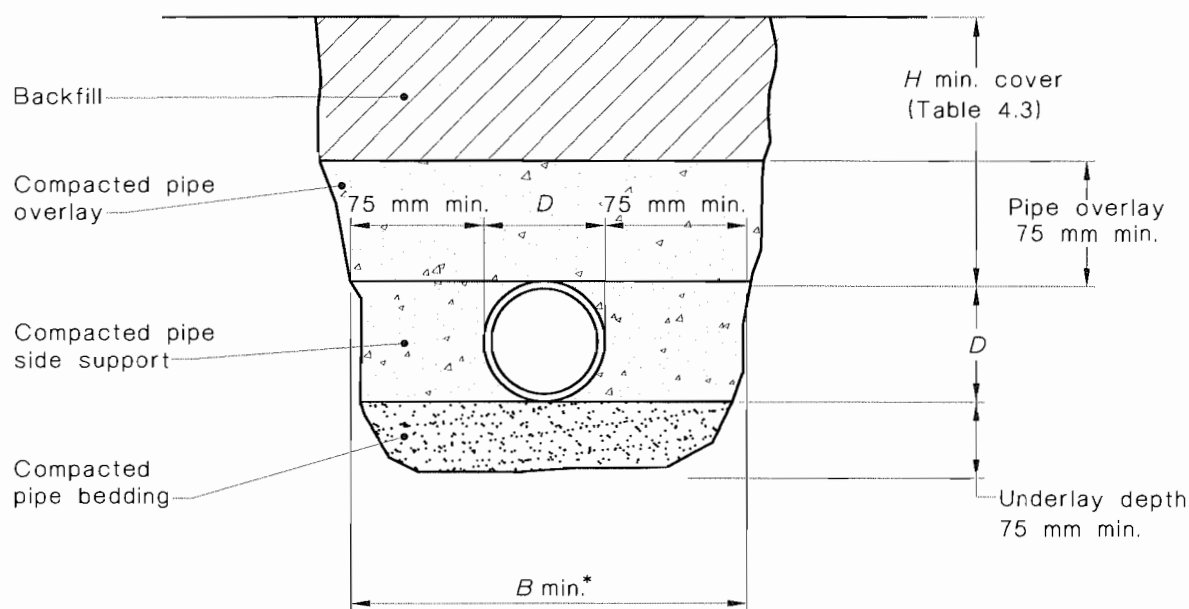
All heated water piping including relief drainpipes, encased in plaster, mortar or similar material shall be wrapped to permit movement due to expansion and contraction.

4.7 BEDDING AND BACKFILL

The water services shall be surrounded with not less than 75 mm of compacted sand, or fine-grained soil, with no hard-edged object permitted to come in contact with or rest against any pipe or fitting (see Figure 4.3).

Backfill shall be free from builder's waste, bricks, concrete pieces, rocks or hard matter larger than 25 mm and broken up so that it contains no soil lumps larger than 75 mm.

Unless specified to the contrary, copper and stainless steel pipelines may be installed in soil excavated from the trench in which it is to be installed, providing the soil is compatible with copper and stainless steel and free from rock and rubble.



$$*B \text{ min.} = D + 150$$

DIMENSIONS IN MILLIMETRES

FIGURE 4.3 TYPICAL INSTALLATION IN A TRENCH

4.8 CONTAMINATED AREAS

4.8.1 General

Any area that may be contaminated by bacterial or chemical pollution shall be deemed to be a contaminated area. These areas shall include ashpits, tanks, ponds, manure bins, waste disposal depots, and wastewater treatment works.

4.8.2 Installation

The installation of any water service in or through a contaminated area shall not be permitted unless the water service—

- (a) is laid through a watertight, corrosion resistant conduit of sufficient length and strength to afford adequate protection to the water service; or
- (b) is fixed not less than 600 mm above the surface of the ground likely to be contaminated.

4.9 CORROSIVE AREAS

Where metallic pipes, metallic fittings or Type M multilayer pipes are installed in a water service in a corrosive area, they shall be externally protected by—

- (a) having an impermeable flexible plastic coating;
- (b) placing in a sealed polyethylene sleeve; or
- (c) continuously wrapping in a petrolatum taping material.

NOTE: Corrosive areas are those that contain substances such as any compound consisting of magnesium oxychloride (magnesite) or its equivalent, coal wash, acid sulfate soils, sodium chloride (salt), ammonia or materials that could produce ammonia.

4.10 DEPTH OF COVER IN PUBLIC AREAS

Where water services are installed below ground in public areas, the minimum cover shall comply with Table 4.3.

Where it is advised that the finished road level is to be lowered by the local authority responsible for roadways, the cover over any water service shall be as shown in Table 4.3 measured from the proposed finished road surface levels.

TABLE 4.3
MINIMUM COVER IN PUBLIC AREAS FOR BURIED PIPING

Location	Minimum cover measure below ground surface level, mm
Unpaved	450
Paved or road surface	450
Solid rock	300

4.11 DEPTH OF COVER IN PRIVATE AREAS

Where water services are installed below ground in private property, the minimum cover shall comply with Table 4.4.

TABLE 4.4
MINIMUM COVER IN PRIVATE PROPERTY FOR BURIED PIPING

Location	Minimum cover measured below ground surface level, mm
Subject to vehicular traffic	300
Under houses or concrete slabs	75
All other locations	225

NOTE: Water services with flexible joints laid below ground in sandy conditions may require a minimum cover of 600 mm.

4.12 PROTECTION AGAINST FREEZING

4.12.1 Requirement for protection

In areas where the ambient temperature frequently falls below 0°C, care shall be taken to avoid the likelihood of the water service being damaged by water freezing within the pipes.

A1 NOTE: See also Section 8.

4.12.2 Piping located outside buildings

A2 All pipes and fittings shall be buried to a minimum depth of 300 mm. Where this is not practicable, the piping shall be covered with waterproof insulation.

4.12.3 Pipes located on metal roofs

Pipes shall not be installed in direct contact with metal roofs. Where it is necessary to run piping across a metal roof, it shall be fixed above the roof and surrounded with a waterproof insulation of minimum thickness as given in Table 4.6 or Table 8.2, as appropriate.

NOTE: Consideration should be made for thermal expansion and contraction of the roof material.

4.12.4 Pipes located inside buildings

4.12.4.1 General

Wherever possible, pipes should be installed so as to avoid those areas of the building that are difficult to keep warm and where temperatures are likely to fall below freezing. These areas include—

- (a) unheated roof spaces;
- (b) unheated cellars;
- (c) locations near windows, ventilators or external doors where cold drafts are likely to occur; and
- (d) locations in contact with cold surfaces, such as metal roofs, metal framework, or external metal cladding materials.

4.12.4.2 Pipes in unheated roof spaces

Pipes in unheated roof spaces shall be located not less than 100 mm from the roof covering and external walls. Where practicable, pipes shall be located under any insulating material laid for restricting heat losses through the ceilings.

4.12.4.3 Pipes adjacent to external walls

Pipes in external walls shall be positioned not less than 20 mm away from the external surface and, where practicable, located on the heated side of any wall insulation present.

4.12.5 Insulation of piping and fittings

Where it is necessary to install piping in areas where temperatures are likely to fall below freezing (see Clause 4.12.4.1), the pipes and fittings shall be surrounded by an appropriate thickness of insulation. Typical example of materials and minimum thicknesses for insulation of various thermal conductivity ranges are given in Tables 4.5 and 4.6 respectively.

NOTES:

- 1 If conditions are particularly severe over an extended time, additional thicknesses of insulation may be necessary to prevent water freezing.
- 2 In situations where the building, or part of the building, is not in use over the winter months, and no heating of the inside areas is maintained, it may be necessary to drain the pipes to prevent damage by freezing of the water. For effective drainage to occur, it is essential for air to freely enter the pipes, and for all draw-off taps and float valves to be left open when draining is being carried out.

TABLE 4.5
TYPICAL EXAMPLES OF INSULATING MATERIALS

Example of material	Thermal conductivity W/m.K
Rockwool or fibreglass section pipe insulation (prefabricated sections)	0.032
Rockwool or fibreglass loose fill or blanket material	0.032–0.045
Flexible polyethylene foam pipe	0.034–0.040
Foamed PVC nitrile rubber	0.040
Loose vermiculite (exfoliated)	0.06–0.07
Pre-insulated copper pipe	0.070–0.075

TABLE 4.6
**MINIMUM THICKNESSES FOR THERMAL INSULATION TO
PREVENT FREEZING OF WATER IN PIPES**

Pipe size	Minimum thickness required, mm				
	Thermal conductivity of insulating material, W/m.K				
	0.03	0.04	0.05	0.06	0.07
DN					
15	9	14	20	29	40
18	6	9	12	15	20
20	4	6	8	10	12
25	3	4	5	6	8
32	2	3	4	5	6

NOTE: The insulation thicknesses were calculated using the equations given in BS 5422 to just prevent freezing of water initially at 15°C if exposed to an ambient temperature of –5°C for a period of 8 h.

4.13 COLD WATER PIPING AND STORAGE TANKS

4.13.1 General

The following requirements apply to the cold water piping to water heaters and storage tanks, and to cold water storage tank piping:

- (a) *Tank connections* Unions or similar couplings shall be used for the connections to the inlet and outlet of a separately mounted cold water storage tank.
- (b) *Cold water storage tank piping* Cold water feed piping between a cold water storage tank, which is not an integral part of a water heater, and the water heater, shall—
 - (i) have a nominal size not less than DN 25 for a displacement water heater, and larger than the nominal size of the heater outlet;
 - (ii) be fitted with a gate valve or other full-way valve of the same nominal size as the piping, if the cold water storage tank has a capacity exceeding 50 L; and
 - (iii) be connected to the water heater inlet by unions or similar couplings to facilitate disconnection.

4.13.2 Cold water storage tank (see Figures 5.1 and 5.2)

4.13.2.1 General

Cold water storage tanks installed to supply water to a water heater shall meet the following requirements:

- AI |
- (a) They shall be constructed of a material complying with Clause 2.3 and having equivalent strength and durability to copper sheet of 0.55 mm thickness.
 - (b) For metal tanks, they shall be—
 - (i) reinforced along the upper edges to prevent distortion of the tank;
 - (ii) welded, brazed or soft-soldered at all joints;
 - (iii) independent of the solder for mechanical strength of soldered joints; and
 - (iv) have joints of a type suitable for the water conditions for which the cold water storage tank is intended.
 - (c) They shall have an outlet of brass or other suitable material threaded in accordance with AS 1722.1 or NZS/BS 21. The outlet shall be—
 - (i) placed as far as practicable from the float valve outlet;
 - (ii) fixed so as to provide a distance of not less than 25 mm between the floor of the tank and the invert of outlet; and
 - (iii) secured into the tank by a method appropriate to the materials to ensure a permanent watertight and mechanically strong connection, which shall not rely on soft solder alone for this purpose.
 - (d) They shall be fitted with a float valve complying with AS 1910;
 - (e) They shall incorporate an air gap in accordance with AS/NZS 3500.1;
 - (f) They shall be clearly and indelibly marked with the static level at which the water is to be set.
 - (g) They shall be fitted with a close-fitting cover, which, in the case of external tanks, shall be adequately secured and of material having corrosion-resisting properties not inferior to 0.5 mm thick galvanized steel sheet complying with AS 1397.

4.13.2.2 Water storage tank capacity

Where a displacement water heater or container is supplied from a remote tank, the tank shall have an effective capacity between the outlet and the marked water level not less than the following:

- (a) *Household installations*—
 - (i) 36 L for water heaters or containers up to and including 400 L capacity; and
 - (ii) 68 L for water heaters or containers greater than 400 L up to and including 700 L capacity.
- (b) *Commercial and industrial installations*—a capacity that shall ensure effective operation of the heated water service under the peak loading conditions that are likely to occur.

NOTES:

- 1 Where the hot water draw-offs are less than those in household premises, a cold water storage tank of the capacity specified in Item (a) should suffice.
- 2 Where large hot water draw-offs are made over a short period, a capacity substantially greater than that specified in Item (a) will be needed.

- 3 Allowance for extra capacity should be made where the cold water storage tank is required to supply water additional to the supply to the water heater.
- 4 In New Zealand allowance has to be made for seismic restraint (see NZBC Clause G12 Water supplies).

4.13.2.3 *Flow capacity*

The capacity of the float valve and all pressure piping to the float valve and connecting pipes from the cold water storage tank to the water heater or container shall be capable of maintaining a water flow rate of not less than—

- (a) 0.21 L/s (12.5 L/min) for water heaters or containers with volumetric storage capacity up to 400 L; or
- (b) 0.27 L/s (16 L/min) for water heaters or containers with volumetric storage capacity greater than 400 L up to and including 700 L.

This flow rate shall be maintained during the drawing-off of the capacity of the water heater or container without the water level of the cold water feed tank falling to a point that allows air to enter either the water heater or container, or the heated water supply piping.

4.13.2.4 *Cold water storage tank overflow*

Each cold water storage tank shall be fitted with an overflow complying with the following requirements:

- (a) The overflow from the cold water storage tank shall be so placed that, with the water in the tank at the marked level, either—
 - (i) a further quantity of water, not less than 3% of the hot water capacity of the heater, can be added before overflow occurs; or
 - (ii) there shall be no discharge from the overflow during the initial heating of the water through a 70°C temperature rise.
- (b) The overflow from an internally mounted cold water storage tank shall discharge into—
 - (i) the safe tray of the cold water storage tanks, terminating not less than 20 mm above the top edge of the safe tray; or
 - (ii) into the waste from the safe tray at a point not less than 75 mm below the floor of the safe tray.
- (c) The overflow shall be so constructed that with the float valve discharging at its maximum flow, with water pressure of 700 kPa and with all service outlets closed, no spillage shall occur from the cold water storage tanks. The vertical distance between the static overflow level and the lowest outlet of the float valve shall be in accordance with AS/NZS 3500.1.
- (d) The overflow from an externally mounted cold water storage tank shall—
 - (i) discharge so as to be readily discernible and not cause a nuisance over windows, open doors or incur damage to buildings or injury to persons; and
 - (ii) be installed in a manner to prevent blockage due to freezing.

4.13.2.5 *Position of cold water storage tanks*

Cold water storage tanks shall be placed in accordance with the following:

- (a) *Mounted on water heater* Where the water heater is supplied complete with an attached cold water storage tank, which is connected to the container, the tank shall not be removed from that position except with the permission of the water heater manufacturer.

- (b) *Separately mounted* Each separately mounted cold water storage tanks shall be placed so that the vertical distance from the marked water level of the tank to the base of the water heater or container does not exceed a height equivalent to the maximum pressure rating marked on the water heater or specified by the manufacturer.

NOTE: See also Clause 4.14.5(c).

4.13.3 Safe tray for cold water storage tanks

Cold water storage tanks fixed in a roof space or other concealed space shall be placed on a safe tray complying with Clause 5.4. Where the tank is mounted on the water heater, a water heater safe tray complying with Clause 5.4 is acceptable as the safe tray for the cold water storage tanks.

NOTE: In New Zealand safe trays are only required where leakage could result in damage to another occupancy in the same building.

4.13.4 Support for separately mounted cold water storage tanks

4.13.4.1 Platform

Each separately mounted cold water storage tank shall be supported on a platform complying with Clause 5.5.

4.13.4.2 Spacing between cold water storage tank and safe tray

The cold water storage tank shall be placed on the safe tray on supports in accordance with Clause 5.4.5.

4.14 INSTALLATION OF HEATED WATER SERVICES

4.14.1 Design and installation

Heated water pipes in a non-circulatory heated water services shall be designed and installed to—

- (a) reduce to a minimum the amount of dead (cold) water drawn off before hot water commences to flow at any tap;
- (b) be sufficient to give the required flow at all outlets (including branches from noncirculatory services);
- (c) be by the shortest practicable route for the main flow heated water pipes and branches to the heated water outlets;
- (d) be the minimum necessary diameter of the heated water pipes required to supply the outlet drawoff; and
- (e) provide a water velocity not exceeding 3 m/s.

NOTES:

- 1 For guidance, typical rates of flow are given in Appendix D.
- 2 Preferred sizes of pipes in Appendix E, to achieve the above requirements.
- 3 Where the distance between hot water outlets causes an excessive amount of dead water, the use of two or more heaters, trace heating of pipes or a pumped circulation should be considered.
- 4 For gradients requirements, see Clause 4.14.4.
- 5 For New Zealand, refer to NZS 4305 for pipe lengths from cylinders to kitchen outlets.

4.14.2 Identification

In other than domestic or residential buildings, where water services are installed in ducts, accessible ceilings and exposed in basements or plant rooms, they shall be identified in accordance with AS 1345 or NZS 5807.

4.14.3 Provision for expansion

4.14.3.1 General

Heated water supply pipes shall be installed with appropriate allowance for expansion and contraction as given in Table 4.7 and shall—

- (a) have sufficient free length of piping around the bend or along the branch to prevent overstressing the pipe and allow for thermal expansion;
- (b) have a clear space to permit movement; and
- (c) have expansion loops, or offsets located at or near midpoint in straight lengths that exceed 18 m, or have expansion joints fitted.

TABLE 4.7
CHANGE IN LENGTH OF COPPER PIPES DUE TO
TEMPERATURE CHANGES

Pipe length, m	Change in length, mm								
	Temperature change, °C								
	20	30	40	50	60	70	80	90	100
≤ 3	2	2	3	3	4	4	5	5	6
>3 ≤ 5	2	3	4	5	6	7	8	8	9
>5 ≤ 9	4	5	7	8	10	12	13	15	16
>9 ≤ 12	5	7	9	11	13	15	17	20	22
>12 ≤ 15	6	8	11	14	16	19	22	24	27
>15 ≤ 20	8	11	15	18	22	25	29	32	36
>20 ≤ 25	9	14	18	23	27	31	36	40	45

4.14.3.2 Expansion of fixed offsets

Where an offset is proposed, provision for thermal expansion shall be made in accordance with Table 4.8.

TABLE 4.8
ALLOWANCE FOR EXPANSION

Run length	Minimum free length of offset	Minimum clearance to obstruction (for 60°C temp. rise)
m	mm	mm
≤4.5	600	5
>4.5 ≤9	900	10
>9 ≤18	1 200	20

4.14.3.3 U-bends, coiled loops, offsets and lyre bends

Allowance for thermal expansion shall be incorporated in the design of relatively long pipe runs and fixing points by the installation of expansion loops or bends, where significantly large temperature differences occur. The required radii for such loops or bends shall be determined by reference to Figure 4.4.

4.14.3.4 Placement of bends and offsets

Expansion loops and offsets shall be placed horizontally to avoid forming air locks at the top of the loops and to ensure proper circulation of the water.

4.14.4 Gradient

The grading of a heated water reticulation service shall comply with the following:

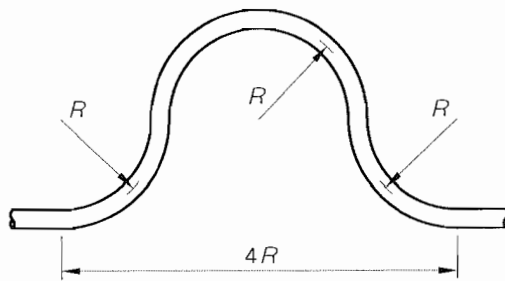
- (a) Mains pressure or pressure-limiting valve-controlled reticulation—rise or fall as required subject to the requirements of Clause 4.14.5.
- (b) Reducing valve-controlled reticulation—rise and fall as required subject to the provisions of Table 4.9.
- (c) Cold water storage tank-fed reticulation—rise or fall continuously in the direction of flow with a minimum grade of 1 in 200.

4.14.5 Maximum rise of heated water supply pipes

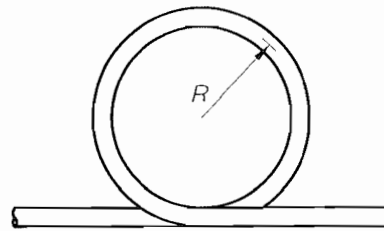
The maximum rise of heated water supply pipes shall be as follows:

- (a) *For mains pressure reticulation*—60% of the available mains pressure expressed in metres head above the level of the cold water inlet.
- (b) *For pressure-limiting valve or pressure-reducing valve controlled reticulation*—60% of the valve setting, expressed in metres head, above the level of the cold water inlet.
- (c) *For cold water storage tank-fed reticulation*—1 m below the marked water level of the cold water storage tank.

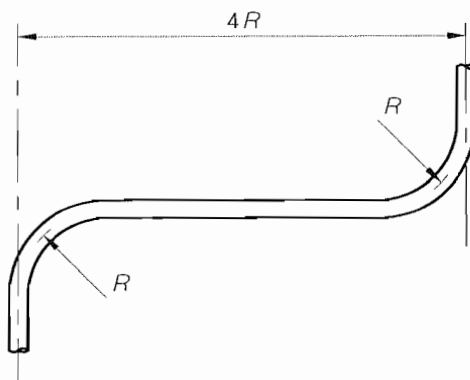
NOTE: For the purpose of this Clause, the equation 10 kPa = 1 m head should be used.



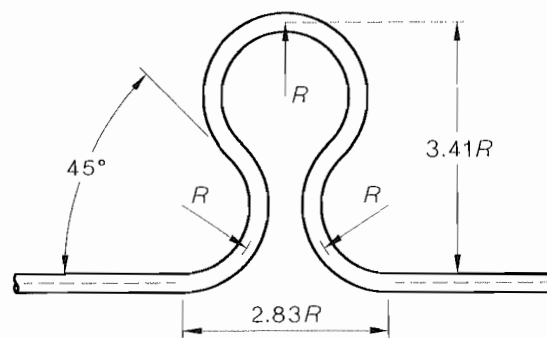
(a) U-bend



(b) Coiled loop



(c) Offset bend



(d) Lyre bend

millimetres

Expansion	Radii for expansion loops or bends (R)									
	DN 15	DN 20	DN 25	DN 40	DN 50	DN 65	DN 80	DN 90	DN 100	DN 125
10	180	210	250	320	350	400	430	470	510	560
15	220	270	290	370	410	440	500	540	600	650
20	250	300	380	430	510	560	620	670	710	790
25	300	350	400	500	550	630	680	730	810	910
30	320	370	430	530	610	660	740	780	840	950
40	340	430	490	620	720	770	870	920	1 000	1 130
50	400	480	550	680	780	880	1 000	1 050	1 150	1 300
60	450	530	630	760	880	960	1 060	1 160	1 260	1 350
70	460	560	660	790	910	1 020	1 130	1 220	1 320	1 450
80	510	610	710	860	990	1 120	1 220	1 320	1 410	1 530
90	610	640	740	920	1 020	1 150	1 250	1 350	1 430	1 550
100	680	760	840	990	1 120	1 190	1 340	1 420	1 470	1 570

NOTE: For pipe sizes DN 18 and DN 32, the next larger pipe size is used.

FIGURE 4.4 PROVISION FOR EXPANSION IN HEATED WATER PIPING

TABLE 4.9
MAXIMUM RISE

Reducing valve setting	Highest point of reticulation above reducing valve outlet
kPa	m
25	1.5
30	1.75
35	2.0
40	2.5
45	2.75
50	3.0
70	4.5
100	6.5

4.14.6 Shower assemblies

Where the hot water is at a lower pressure than the cold water, the heated and cold water mixing assembly shall be constructed so that the cold water flow does not seriously restrict the hot water flow.

4.14.7 Venting of secondary circuit

Each low-pressure-fed secondary circuit shall be vented at the highest point of the rise on the secondary flow pipe by either—

- (a) a vertical vent pipe complying with Clause 5.13; or
- (b) an automatic air elimination device suitable for that purpose.

4.14.8 Terminal fittings

In new installations, the hot water tap, when installed in combination with a cold water tap, shall be the left hand or upper tap.

NOTE: For New Zealand, other tap arrangements may be allowed.

4.14.9 Recirculation of cold water

A heater water return line may be returned to the water heater inlet by either—

- (a) connecting between the non-return valve and the water heater (see Figures 5.9 and 5.10); or
- (b) connecting to the cold water pipes using an authorized product installed in accordance with the product Standard.

A2

SECTION 5 INSTALLATION OF WATER HEATERS — GENERAL REQUIREMENTS

5.1 SCOPE OF SECTION

This Section sets out general requirements for the installation of water heaters, their location, support, cold water service valves, the vent or drain lines, and the first 2 m of heated water supply piping.

Refer to Section 7 for energy efficiency installation requirements.

5.2 WATER HEATERS

5.2.1 Water heaters

Water heaters shall be installed in accordance with the manufacturer's instructions, and shall comply with the requirements of the relevant water heater Standard.

5.2.2 Selection of anode

A2 | Any anode fitted to a water heater shall be compatible with the water supplied to the water heater (see Clause 1.6 and Appendix B).

NOTE: Refer to the water heater manufacturer for information about the suitability of the anode.

5.2.3 Working pressure

Water heaters shall be installed so that the maximum rated working pressure is not exceeded during normal operation. Reference shall be made to the heater label for the relevant information.

5.2.4 Auxiliary controls

Auxiliary controls shall be mounted in accordance with the manufacturer's instructions and adjusted, as required.

5.3 LOCATION

5.3.1 Placement

The water heater shall be placed as close as practicable to the most frequently used outlet point or points. Consideration shall be given to the route taken by vent pipes, drain lines or safe wastes.

5.3.2 Accessibility and clearances

Water heaters shall be located and oriented in accordance with the following:

- (a) The rating plate and instruction notice shall be in a ready position visible.
- (b) Unobstructed access shall be available to the burner, heating units, controls, cold water storage tanks and other apparatus requiring maintenance.
- (c) All valves and the easing gear on a relief valve shall be readily accessible.
- (d) There shall be 150 mm minimum clearance from the end of the easing gear of temperature/pressure-relief valves to allow for valve removal.
- A2 | (e) The heater shall be subsequently removable without major structural alteration to the building or major alteration to the piping.

NOTES:

- 1 Wherever practicable, clearance should be allowed for removal and replacement of anodes, where fitted.
- 2 For cold water storage tank-fed water heaters, see also Clause 4.13.3.

5.3.3 Ventilation and fluing

Fuel-burning water heaters shall be located so that the correct ventilation and fluing can be provided in accordance with the manufacturer's instructions and relevant codes and Standards.

5.4 PROTECTION AGAINST DAMAGE FROM LEAKING WATER

5.4.1 Concealed water storage tanks

All water containers, cold water storage tanks, cold water storage tank-fed water heaters or storage water heaters that are installed in roof spaces, in cupboards or otherwise concealed shall be placed on safe trays complying with Clause 5.4.3. The safe trays shall be drained by safe wastes complying with Clause 5.4.4.

Notwithstanding the above requirements, mains pressure water heaters may be installed on a safe tray without a safe waste, provided an approved shut-off device is fitted adjacent to the cold water inlet and upstream of any expansion control valve (see Clause 5.9.3 (f) and Figure 5.5).

A2 | 'Text deleted'

5.4.2 Unconcealed water storage tanks

A2 | Unconcealed water storage tanks, installed inside buildings on or above a floor surface that is impervious to water and suitably drained to a trapped or untrapped floor drain or an external doorway, do not require safe trays.

Mains pressure water heaters may be installed on a safe tray without a safe waste, provided an approved shut-off device is fitted adjacent to the cold water inlet and upstream of any expansion control valve.

All other unconcealed water storage tanks that are installed inside buildings shall be installed on safe trays complying with Clause 5.4.3 and 5.4.4.

NOTE: Free outlet-type storage water heaters, not exceeding 13.5 L capacity, and instantaneous water heaters do not require safe trays.

5.4.3 Safe tray construction

Safe trays shall be fabricated from materials that comply with the requirements of Clause 2.5. The sides of the safe tray shall be turned up not less than 50 mm. All joints shall be made watertight.

5.4.4 Safe wastes

5.4.4.1 Sizes of safe wastes

The minimum sizes of safe waste pipes shall be—

- (a) DN 25 for safe trays in under-sink situations; or
- (b) DN 50 (DN 40 New Zealand only) for all other situations.

5.4.4.2 Safe waste construction

Safe wastes shall be fabricated with all joints in sheet metal pipe lapped in the direction of the flow and all circumferential joints made watertight.

5.4.4.3 Safe waste installation

Each safe waste shall comply with the following:

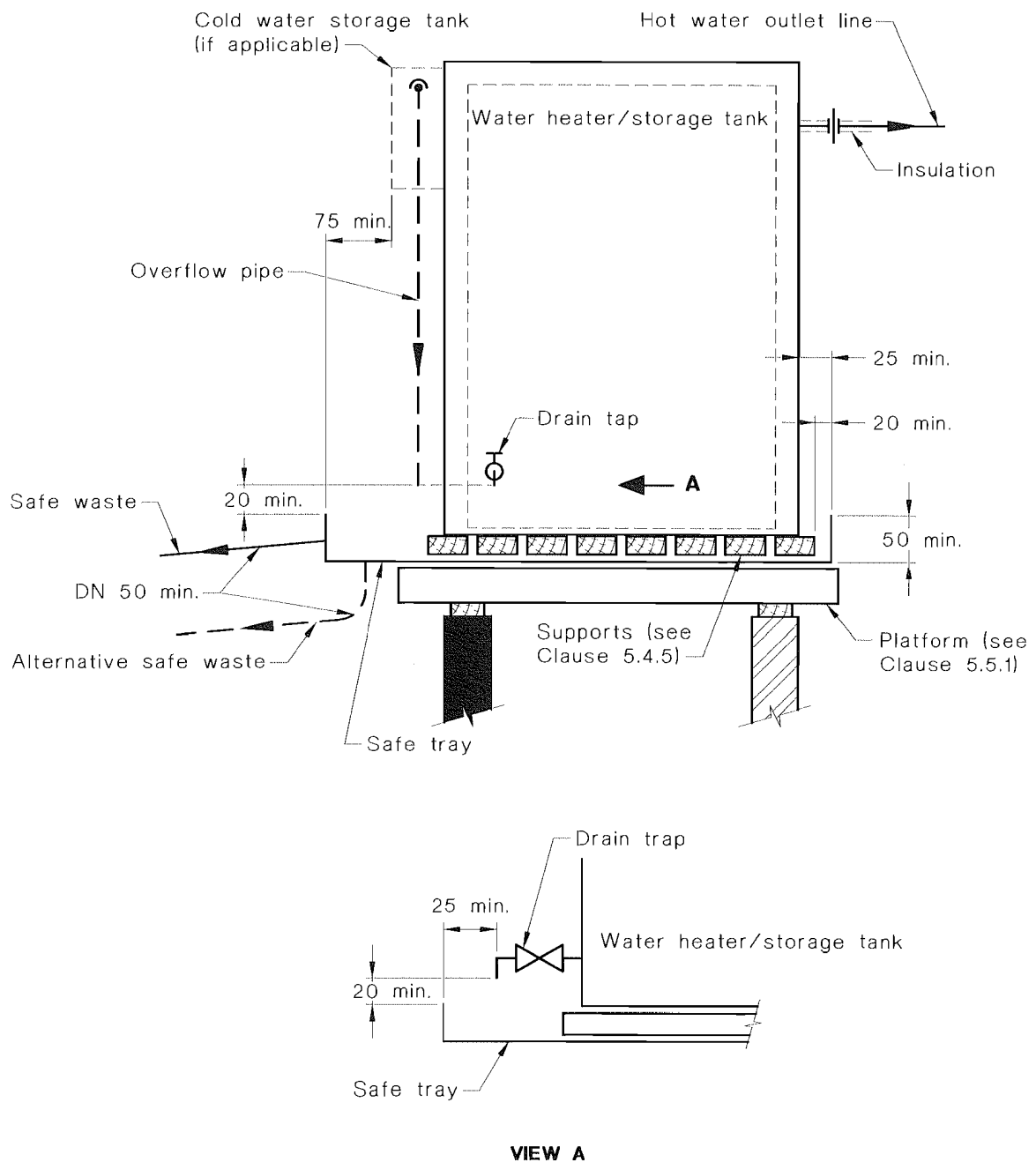
- (a) It shall have a continuous fall to its discharge point.
- (b) All seams in sheet metal pipe shall be uppermost.

- (c) It shall include support in the vicinity of the tray and at intervals not greater than 1 m horizontally and 2.4 m vertically.
- (d) The discharge position shall comply with the following:
 - (i) Where discharging outside the building, it shall discharge to a point within the property boundaries which is readily visible from within the property, clear of doors, windows and other openings and is unlikely to cause injury to people or damage to property.
 - (ii) Where discharging inside the building, it shall discharge to a readily visible position that is unlikely to cause injury to people or damage to property.
 - (iii) Where cold water storage tanks or cold water storage tank-fed water heaters are outside the building, it shall discharge to a readily visible position.

5.4.5 Placement of water heater or cold water storage tank on a safe tray

The water heater or cold water storage tank shall be placed on a safe tray (see Figure 5.1) and shall comply with the following:

- (a) It shall have no portion of any attached feed tank closer than 75 mm to a vertical line from the edge of the safe tray and no portion of the heater or cold water storage tank or any attached auxiliary part closer than 25 mm to the vertical line; and
- (b) It shall have placed between the tank and the safe tray, supports not less than 12 mm thick and of an area not less than $0.5 A$, nor more than $0.6 A$, where A is the area of the base of the tank. The support shall project beyond the sides and walls of the tank but not closer than 20 mm to the sides of the safe tray.



DIMENSIONS IN MILLIMETRES

FIGURE 5.1 TYPICAL INSTALLATION OF A SAFE TRAY AND POSITION OF WATER HEATER OR COLD WATER STORAGE TANK

5.5 SUPPORT

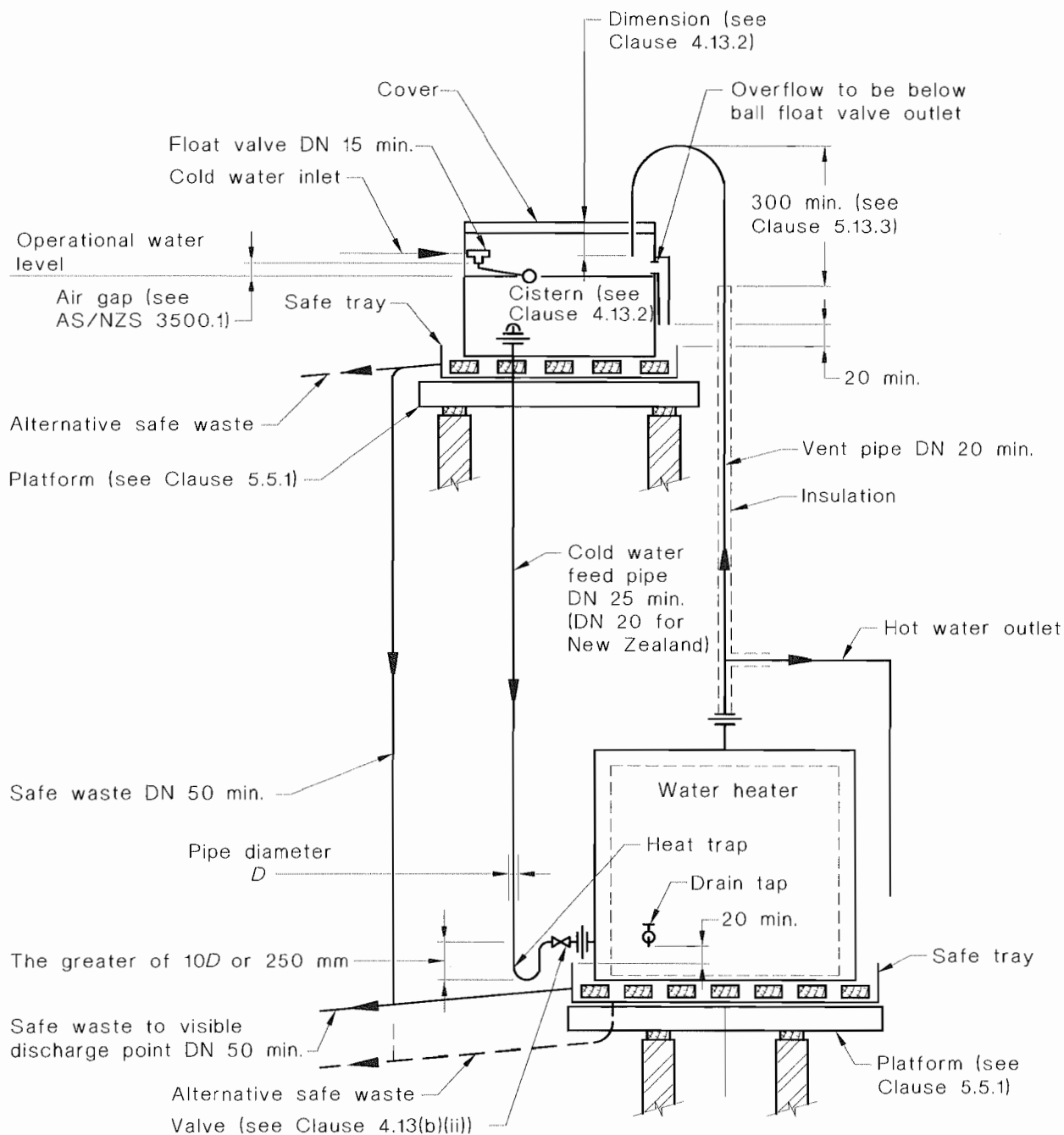
5.5.1 Support of water storage tanks installed in a roof

Storage water heaters and cold water storage tanks installed in a roof space (see Figure 5.2) shall be placed on a safe tray that is supported by a platform of hardwood or other suitable and not less durable material as shown in Figure 5.3 and complying with the following requirements:

- (a) The safe tray shall drain to its safe waste.

- (b) The safe tray shall be placed so that the load of the water heater or cold water storage tank is supported by one or more load-bearing walls that are vertically continuous to a solid foundation, a concrete slab or similar support of comparable strength, and in accordance with the following:
- (i) Where the platform is placed over one wall only, it shall be placed centrally over the wall, and any ceiling joist that is subjected to additional stress shall cross the wall at right angles. The capacity of the water heater or cold water storage tank, or both, supported by the platform, shall not in this case exceed 450 L.
 - (ii) Where the load is carried by beams or bearers spanning two walls, no ceiling joists shall carry any of the load, except where immediately over a wall.
 - (iii) Where the load is carried on load-bearing walls supported on piers, the water heater or cold water storage tank shall be placed centrally above a solid pier that supports the wall immediately under the water heater or cold water storage tank, or the load shall be transmitted to a designed floor beam or bearer supported by two piers not more than 2 m apart.
- A2 (c) Where the roof is constructed from trusses, the platform supporting a water storage tank shall not be supported from any part of the trusses unless the trusses are specifically designed to carry the load of the water storage tank.

NOTE: These requirements do not preclude the load or part of the load from being carried on a beam or bearer that spans an opening in a wall. As such, the wall immediately above the opening is not subjected to additional stress and the load is distributed over at least 0.6 m of vertical continuous wall on either side of the opening.



DIMENSIONS IN MILLIMETRES

FIGURE 5.2 TYPICAL INSTALLATION IN ROOF SPACE OF COLD WATER STORAGE TANK-FED WATER HEATER WITH SEPARATELY MOUNTED COLD WATER STORAGE TANK

5.5.2 Support of water heaters or water storage tanks installed above a roof

Storage water heaters (other than solar water heaters) and cold water storage tanks installed above a roof shall be supported on a platform that is not less durable than timber complying with Clause 2.9.1, and complying with the following:

- The clearance between the lowest part of the platform and the roof shall be not less than 75 mm;
- The load shall be distributed over two walls continuous to a solid foundation without any stress being placed on the roof structure.

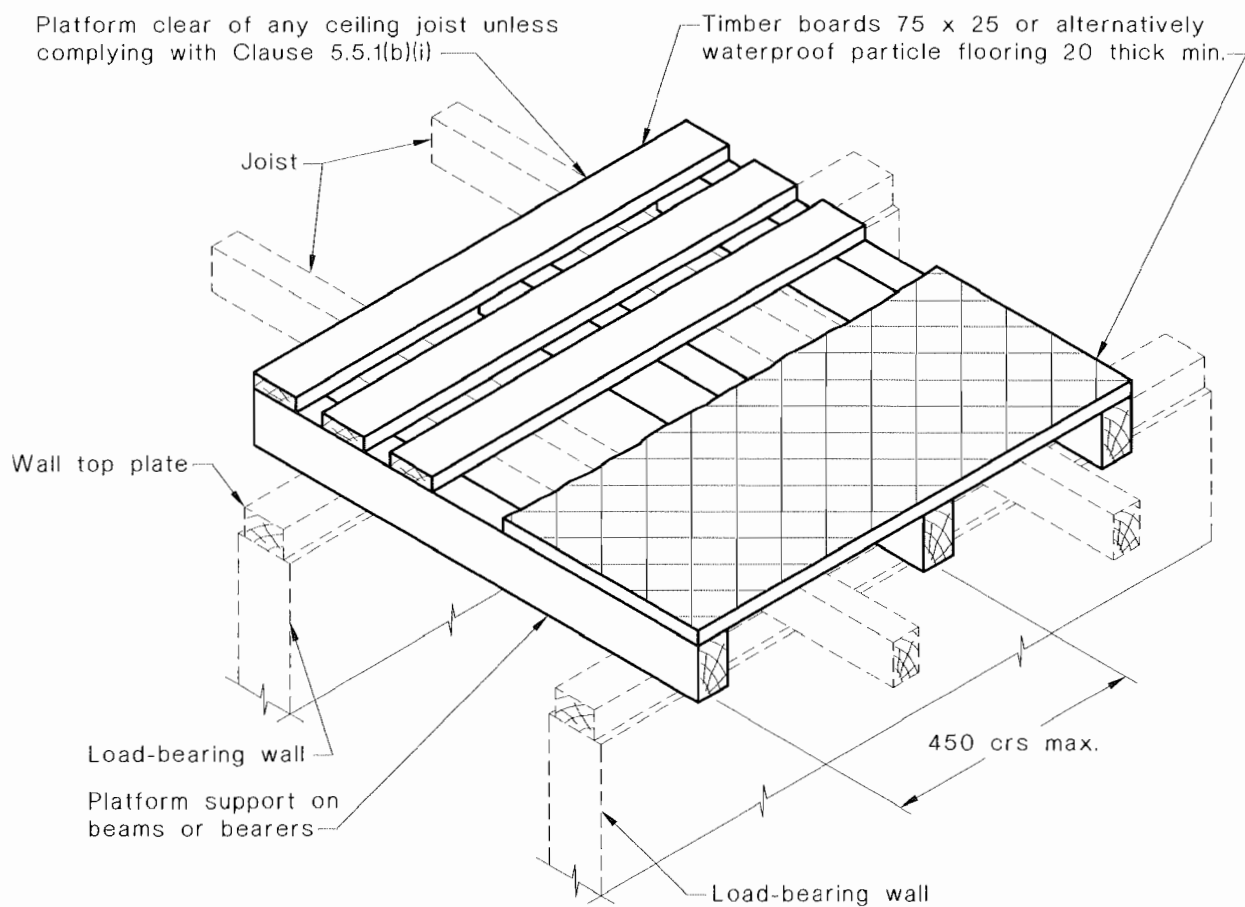
- (c) It shall have structural members that penetrate the roof flashed or rendered watertight in a manner that will allow for expansion and be appropriate to the construction.
- (d) In cyclone-prone areas, it shall comply with the requirements of the regulating authority.

A1 | NOTE: For close-coupled solar water heaters, see Clause 6.2.2.

5.5.3 Support of water heaters or water storage tanks installed other than in a roof space or above a roof

Storage water heaters and cold water storage tanks installed other than in a roof space or above a roof shall be floor-mounted, or supported, as follows:

- (a) By brackets or hangers supplied by, or as specified by, the manufacturer, and installed in accordance with the manufacturer's instructions.
- (b) In a recess in a wall structure, as specified by the manufacturer.
- A2 | (c) On a level, stable and impervious base designed and located to avoid ponding and made of—
 - (i) bonded brick or concrete cast in situ, having a thickness of not less than 75 mm; or
 - (ii) pre-cast concrete having a thickness of not less than 50 mm.
- (d) On a platform of timber, as shown in Figure 5.3, or other suitable and not less durable material. Where such a platform is located at or near ground level, it shall be supported so that a clearance of not less than 100 mm is maintained from the surrounding ground.

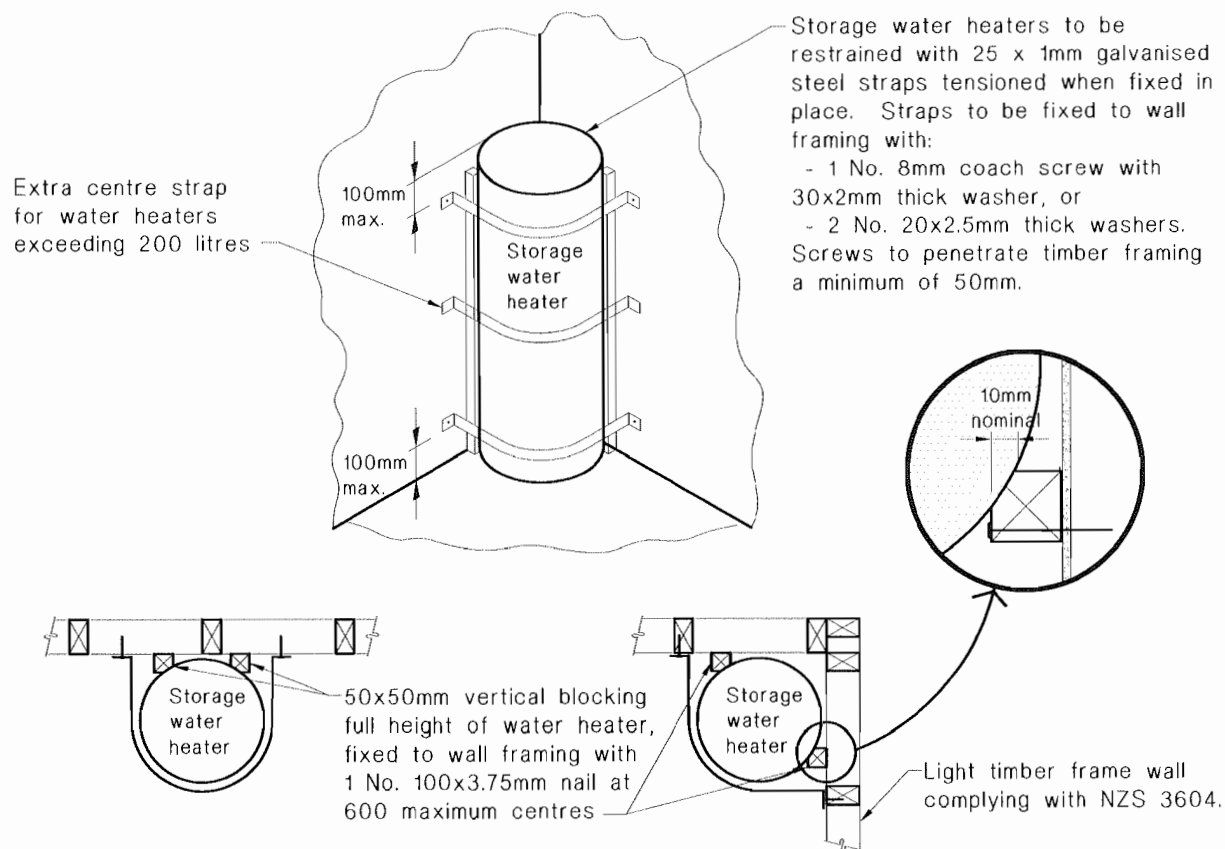


DIMENSIONS IN MILLIMETRES

FIGURE 5.3 TYPICAL CONSTRUCTION OF A PLATFORM

5.5.4 Seismic restraints

In New Zealand cold water storage tanks and hot water container assemblies are required to be restrained against movement (see NZS 4603 or NZS 4607 and Figure 5.4).



DIMENSIONS IN MILLIMETRES

FIGURE 5.4 TYPICAL ARRANGEMENT FOR SEISMIC RESTRAINT OF STORAGE WATER HEATERS LESS THAN 350 L (NEW ZEALAND ONLY)

5.6 CORROSION PREVENTION AND WEATHER PROTECTION

5.6.1 Water heater base—Corrosion avoidance

Water heaters, supported on a surface that may become wet shall be installed to allow a free air circulation between the surface and the base of the water heater unless stated otherwise in the manufacturer's written installation instructions.

5.6.2 Weather protection of externally installed water heaters

Water heaters installed externally shall—

- be of a type designed for external installation; or
- be protected by a weatherproof enclosure.

NOTE: A water heater or enclosure complying with the above requirements may not necessarily be suitable for extreme conditions, such as sustained freezing temperature or for salt-laden or corrosive atmospheres. For installations, under such conditions, reference should be made to the water heater manufacturer.

5.7 CONNECTIONS TO WATER HEATERS

Unions or similar couplings shall be provided for the connections of any service pipe to the inlet or outlet of the water heater.

5.8 PRESSURE RELIEF AND VENTING OF WATER HEATERS AND CONTAINERS

The following requirements apply:

- (a) *Vented storage water heaters*—the storage container of the heater shall be fitted with a free and unobstructed vent open to be atmosphere at all times.
- (b) *Vented heat exchange water heaters*—shall fitted with a vent and protective devices as required in AS 3498.
- (c) *Unvented storage water heaters* shall be fitted—
 - (i) with a temperature/pressure-relief valve as shown in Figures 5.7 and 5.10(a) and
 - (ii) with an expansion valve, where specified or required by regulation.

NOTES:

- 1 In New Zealand only, when the valve set pressure is not greater than 120 kPa, a pressure-relief valve may be used in lieu of a temperature/pressure-relief valve.
- 2 In New Zealand expansion control valves are required to be fitted to all unvented (i.e., valve vented) cylinders.

- (d) *Instantaneous water heaters*—shall be fitted, where necessary, with pressure protective device(s) for the particular type of water heater.
- (e) *All heaters*—shall be fitted with any additional protection devices specified by the manufacturer of the water heater.

Unvented pressure water containers, not designed to withstand a full vacuum, shall be fitted with a vacuum-relief valve.

NOTES:

- 1 A vacuum-relief valve is usually incorporated in the pressure-relief valve on this type of container. A separate vacuum-relief valve is only required where the manufacturer so specifies.
- 2 In New Zealand, 'valve vented', describes water heaters that are vented by valves rather than by an open vent pipe.

5.9 VALVES

5.9.1 General

The valves used in the installation of water heaters, shall comply with Tables 5.1 and 5.2.

5.9.2 Required set pressure of valves (for unvented water heaters)

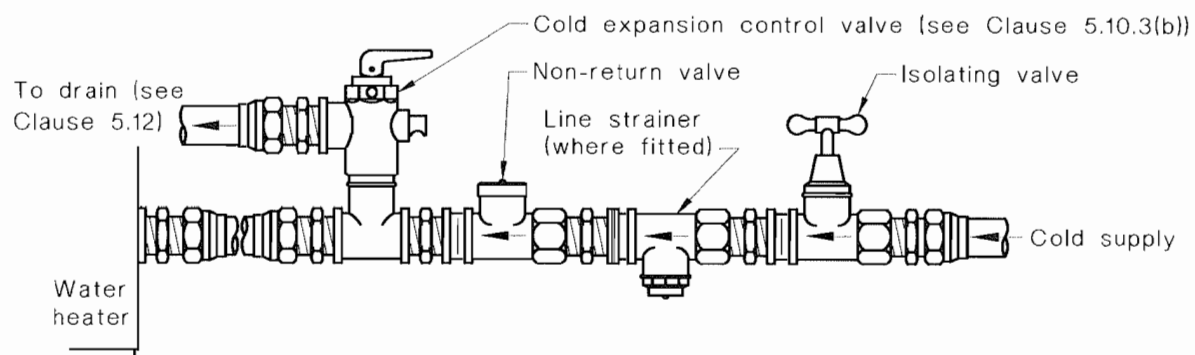
The required set pressure of expansion-control valves and inlet-pressure-control valves shall be—

- (a) as specified by the water heater manufacturer; or
- (b) determined from the set pressure of the temperature and pressure-relief valve supplied by the water heater manufacturer, with reference to Table 5.2.

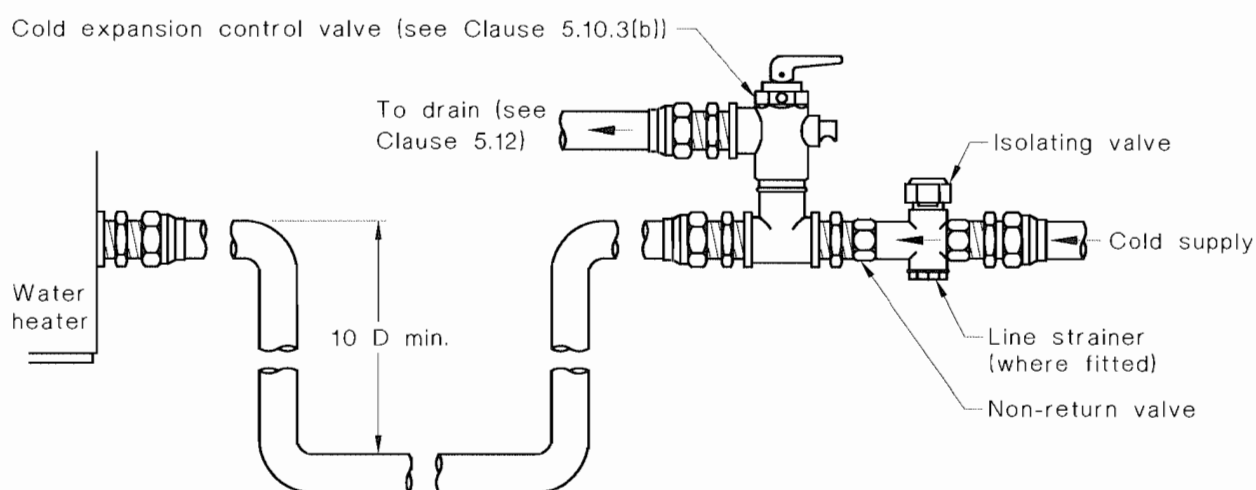
5.9.3 Installation of valves

The valves shall be installed in accordance with manufacturer's instructions and in a manner appropriate to the type of water heater being installed (see Figures 5.8 to 5.13 for typical installations). The installations shall—

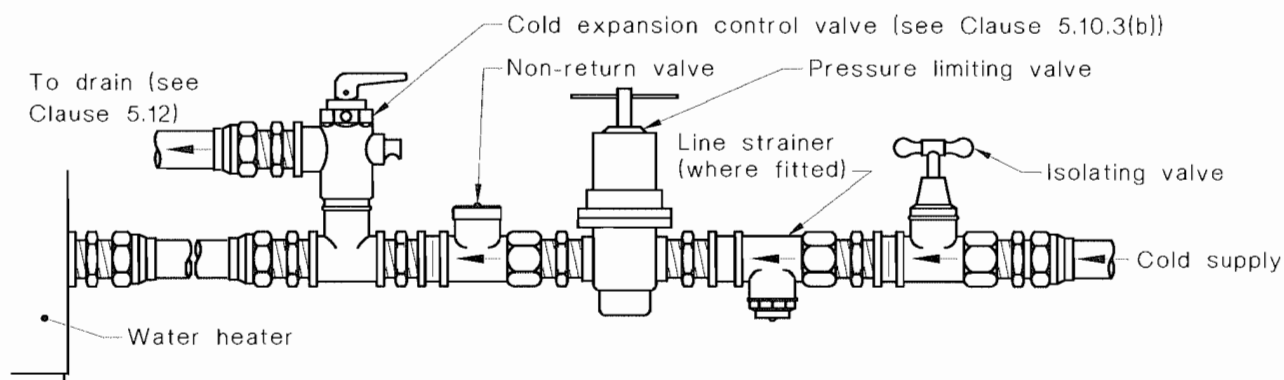
- | | |
|----|---|
| A2 | <ul style="list-style-type: none"> (a) have the isolating valve in a position readily accessible from floor or finished surface level; (b) have the valves in the cold water supply in the sequence shown in Figure 5.5 as either separate or as a combined unit; (c) have unobstructed access for maintenance or replacement and meet the requirements of Clause 5.3.2(c) and (d); (d) have no heat applied to any valve that has screwed pipe connections; (e) have no other valve, tap or shut-off device between the temperature/pressure-relief valve or pressure-relief valve and the water heater; (f) except for the heater isolating valves required in Clause 5.10.2(h) for multiple installations, have no other valve, tap or shut-off device between any expansion control valve and the inlet to the water heater; (see Figure 5.5) |
| A2 | <ul style="list-style-type: none"> (g) have the temperature/pressure-relief valves fitted in the position specified by the water heater manufacturer; and (h) be protected from freezing where climatic conditions require. (i) 'Text deleted' |



(a) Typical assembly of individual components



(b) Typical assembly of cold water components (combined assembly showing heat trap)



(c) Typical assembly of cold water components incorporating a pressure limiting valve

NOTE: Expansion control valve may be combined with the pressure-limiting valve.

FIGURE 5.5 TYPICAL INSTALLATION OF VALVES

TABLE 5.1
VALVE AND FITTING REQUIREMENTS FOR WATER HEATERS

Valves and fittings	Instantaneous water heaters	Valves and fittings required						Heat exchange water heater (Figure 5.6)
		Unvented water heater		Vented water heater				
		Mains pressure (Figures 5.7 and 5.8)	Unvented reduced pressure (Figure 5.8(a))	Vented reduced pressure (Figure 5.8(b))	Reduced pressure uncont. heat source (Figure 5.10)	Free outlet water heater	Side fed water heater	
Isolating valve	Yes‡	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Line strainer	*	*	*	*	*	N/A	*	*
Non-return valve	N/A	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Pressure-limiting valve	As required by Table 5.2	As required by Table 5.2	As specified by the reducing valve manufacturer			N/A	N/A	As required Table 5.2
Pressure-reducing valve	N/A	N/A	Yes	Yes	Yes	N/A	N/A	N/A
Expansion control valve (Australia)	*	*	*	N/A	N/A	N/A	N/A	Yes
Expansion control valve (New Zealand)	N/A	Yes	Yes	N/A	N/A	N/A	N/A	Yes
Vacuum relief valve	N/A	As required by the water heater manufacturer	As required by the water heater manufacturer	N/A	N/A	N/A	N/A	N/A
Tempering valve (Note 2)	Optional	Optional	Optional	Optional	Yes	Optional	Optional	Optional
Temperature and pressure-relief valve†	N/A	Yes	Yes	N/A	N/A	N/A	N/A	N/A
Other protective devices	As specified by the manufacturer							

* Where specified or required by regulation.

† In New Zealand where the valve set pressure is not greater than 120 kPa, a pressure-relief valve may be used in lieu of a temperature/pressure-relief valve.

‡ Isolating valves shall provide full flow.

NOTES:

1 This Table is not applicable to a water heater fed from a remote cold water storage tank.

2 Tempering valves are not recommended for commercial-type kitchens or dishwashing areas (see Clause 1.6 for temperature control).

3 For Australian valve requirements (see AS 1357) and for New Zealand valve requirements (see NZS 4608).

TABLE 5.2
SET PRESSURES FOR VALVES

TPR valve or pressure- relief valve setting	Without expansion control valve		With expansion control valve			Inlet pressure control valve type required
	Maximum permitted mains pressure	Inlet valve maximum setting	Exp. control valve setting	Maximum permitted mains pressure	Inlet valve maximum setting	
kPa	kPa	kPa	kPa	kPa	kPa	kPa
Open vent	N/A	35	N/A	N/A	N/A	Pressure reducing
56	N/A	45	46	N/A	35	Pressure reducing
74	N/A	65	65	N/A	55	Pressure reducing
Open vent	N/A	76	N/A	N/A	N/A	Pressure reducing
80	N/A	65	65	N/A	50	Pressure reducing
85	N/A	70	70	N/A	55	Pressure reducing
100	N/A	85	85	N/A	70	Pressure reducing
115	N/A	100	100	N/A	85	Pressure reducing
120	N/A	110	110	N/A	100	Pressure reducing
130	N/A	115	115	N/A	100	Pressure reducing
150	N/A	130	130	N/A	115	Pressure reducing
180	N/A	160	160	N/A	140	Pressure reducing
215	N/A	195	195	N/A	175	Pressure reducing
500	400	350	400	350	300	Pressure limiting
700	550	450	550	450	350	Pressure limiting
850	680	500	700	550	450	Pressure limiting
1 000	800	600	850	680	500	Pressure limiting
1 200	960	600	1 000	800	600	Pressure limiting
1 400	1 120	600	1 200	960	600	Pressure limiting
N/A	N/A	N/A	1 400	1 100	600	Pressure limiting

NOTE: Inlet pressure-control valve is required where the maximum permitted mains pressure is likely to be exceeded.

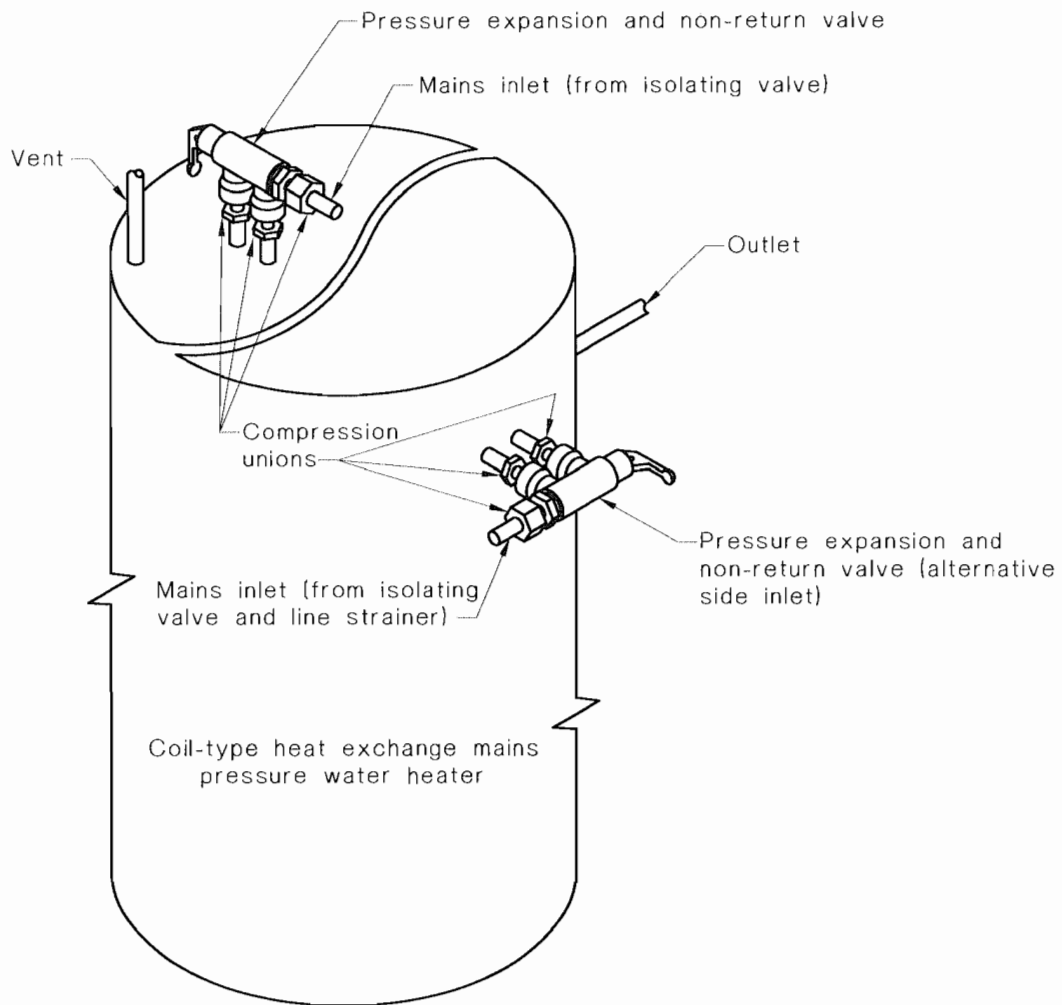
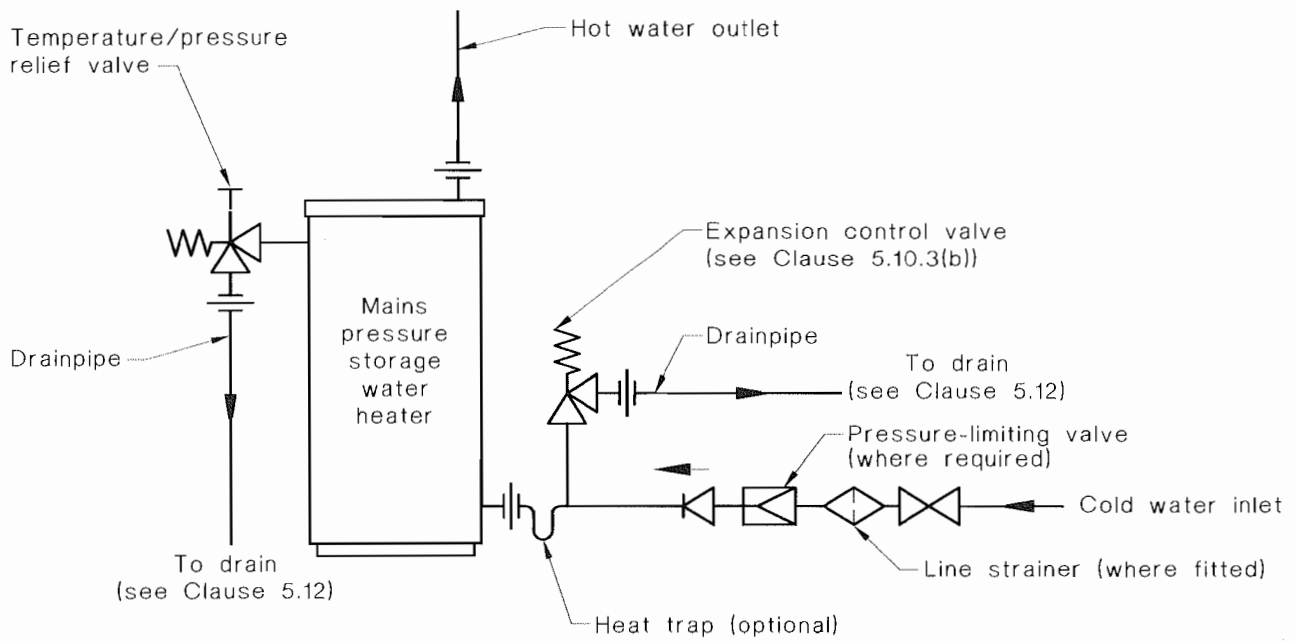
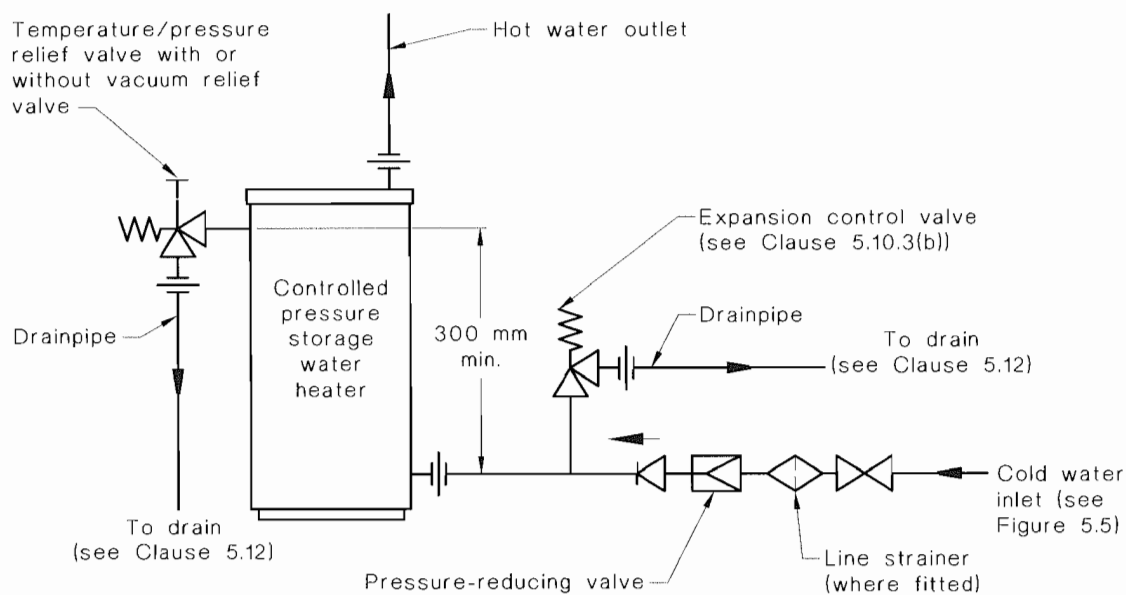


FIGURE 5.6 TYPICAL INSTALLATION OF A HEAT EXCHANGE MAINS PRESSURE WATER HEATER FITTED WITH A COMBINATION EXPANSION CONTROL VALVE AND NON-RETURN VALVE

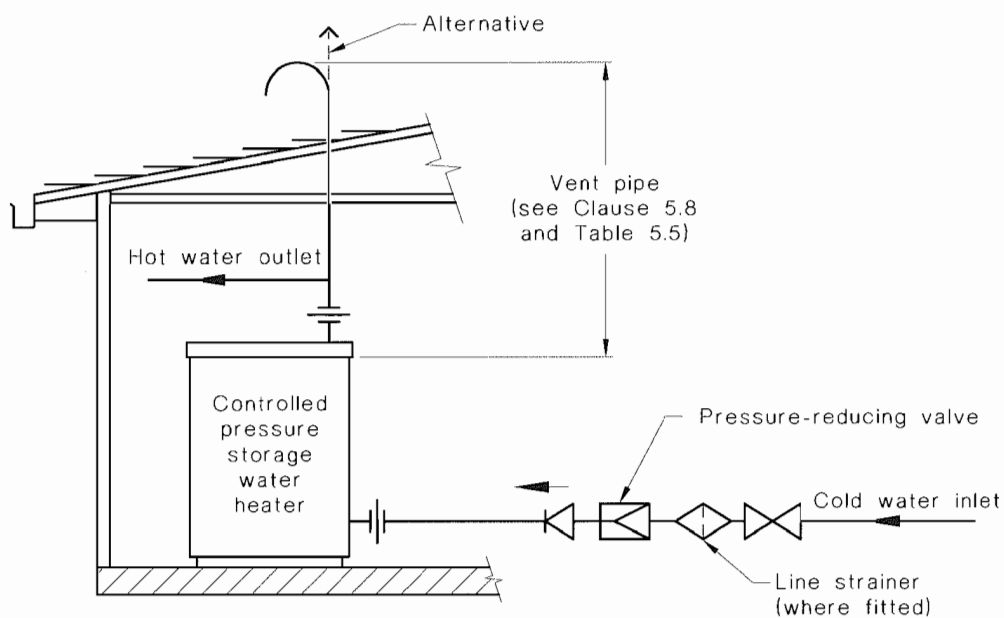


NOTE: Expansion control valve may be combined with the pressure-limiting valve.

FIGURE 5.7 TYPICAL INSTALLATION OF A MAINS PRESSURE STORAGE WATER HEATER



(a) With temperature/pressure and vacuum relief valve



(b) With vent pipe

FIGURE 5.8 TYPICAL INSTALLATION OF A PRESSURE WATER HEATER CONTROLLED WITH A PRESSURE-REDUCING VALVE

5.10 MULTIPLE INSTALLATIONS OF PRESSURE-TYPE STORAGE WATER HEATERS

5.10.1 General

Where large volumes of hot water are required over a short period, several pressure-type storage water heaters may be combined into one service.

Each water heater shall be fitted with temperature/pressure-relief valve(s) in accordance with Table 5.1.

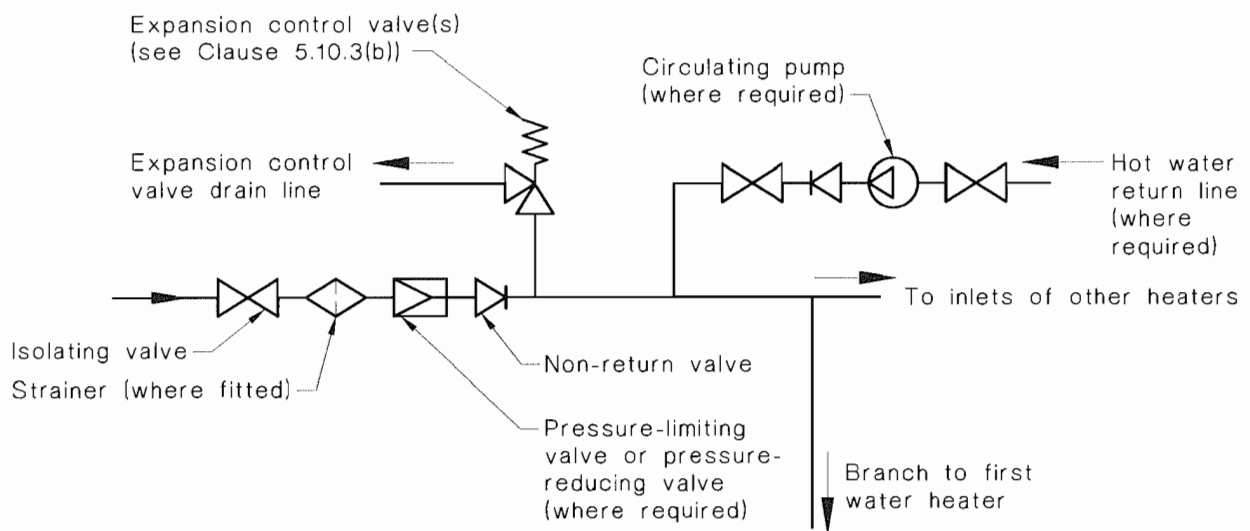
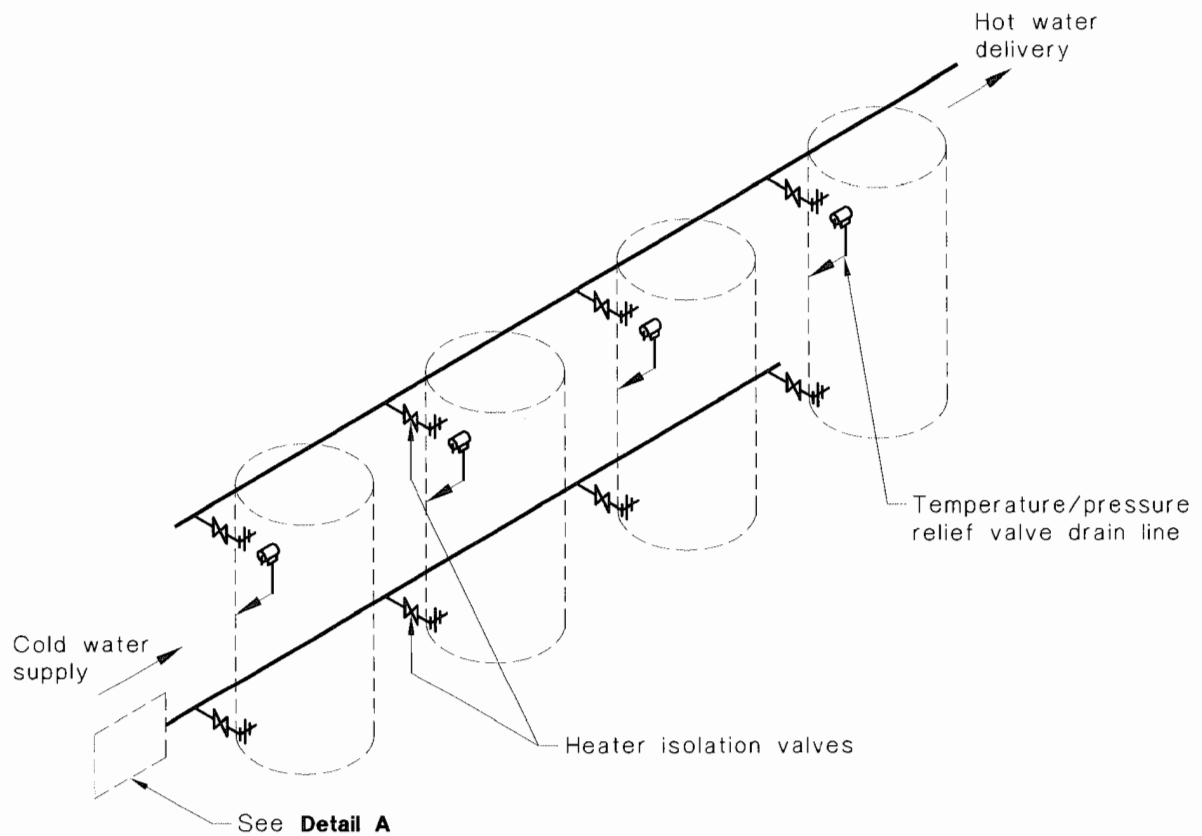
In all such installations, access shall be provided in front of each water heater for servicing and for the removal of any one water heater without the need to disconnect any others.

5.10.2 Balanced flow conditions

For new installations, banks of storage water heaters shall be installed in accordance with the following to ensure similar resistance to flow through all the heaters in the bank and that each delivers similar volumes of hot water at a similar temperature:

- (a) The water heaters shall be of the same storage capacity and energy input capacity, with the same nominal temperature setting and be connected in parallel.
- (b) The cold water service to the inlet header shall enter the bank from the opposite end to that from which the heated water service leaves the outlet header as shown in Figures 5.9 and 5.10.
- (c) The heated water return in a recirculation system shall connect to the cold water header, as shown in Figure 5.9, or to a return header, as shown in Figure 5.10, and enter the bank from the opposite end to that from which the heated water service leaves the outlet header.
- (d) Inlet and outlet headers shall be of the same nominal size and length and wherever possible, the same shape with identical connections. The size of the headers shall be either the nominal size or the minimum size (see Table 5.3), whichever is the larger.
- (e) All inlet branch pipes shall be of the same nominal size and, wherever possible, be of the same length and shape.
- (f) All outlet branch pipes shall be of the same nominal size and, wherever possible, be of the same length and shape.
- (g) Where a hot water return header is installed, all return branch pipes shall be of the same nominal size and, wherever possible, be of the same length and shape i.e. balanced.
- (h) Heater isolating valves shall be fitted to inlet, outlet and return branch pipes. These valves shall be full-way, gate valves or ball valves and be of the same nominal size as the pipe to which they are fitted.
- (i) Offtakes shall not be connected to any branch pipe or any intermediate part of the headers.

NOTE: For existing installations, where alterations and additions are required, the provisions of this Clause should be applied wherever practicable.



DETAIL A

FIGURE 5.9 TYPICAL IN-LINE ARRANGEMENT OF MULTIPLE STORAGE WATER HEATERS

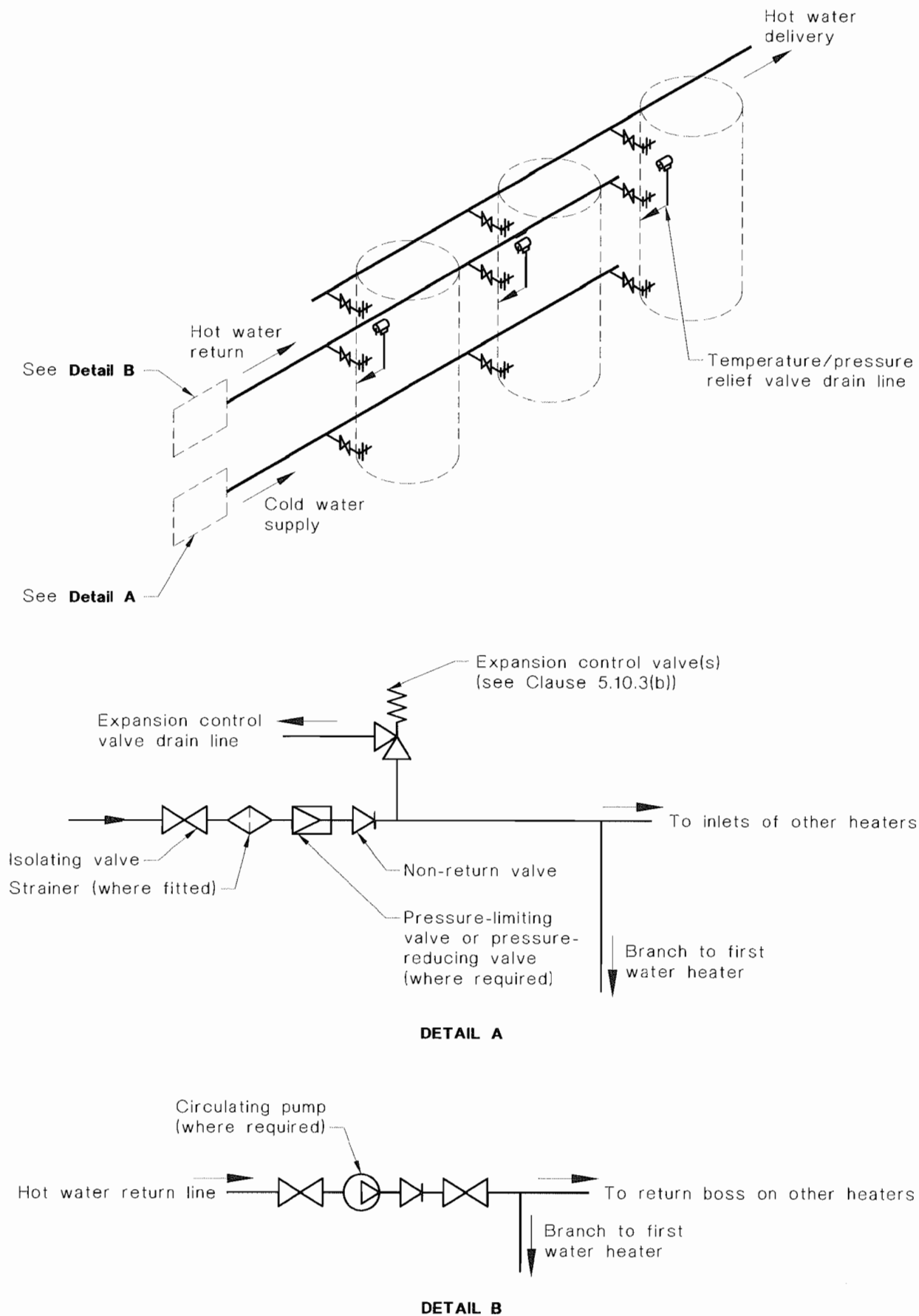


FIGURE 5.10 ALTERNATIVE ARRANGEMENT OF HEATED WATER RETURN LINE FOR CIRCULATING HEATED WATER SERVICE

TABLE 5.3
HEADER SIZES FOR MULTIPLE INSTALLATIONS

Number of heaters in bank	Nominal size of headers	Minimum size of headers DN
2	Same pipe size as branch pipes	20
3–5	One pipe size larger than branch pipes	25
6–10	Two pipe sizes larger than branch pipes	32
11–15	Three pipe sizes larger than branch pipes	40

5.10.3 Positioning and sizing of pressure-control valves

Where water heaters installed in a multiple configuration (see Figure 5.9) require pressure-control valves to be included in the installation, the following requirements shall be met:

- (a) *Inlet-pressure-control valves* Inlet-pressure-control valves, where required, shall be installed between the cold water supply isolating valve and the branch to the first water heater. Where two or more inlet-pressure-control valves are fitted in parallel, they shall be of the same pressure setting. The assembly shall have a flow capability that is not less than that of a single valve one size smaller than the cold water supply pipe.
- (b) *Cold water expansion control valves* Where required by the local regulatory authority, one or more expansion control valves shall be installed immediately after the cold water isolation valve and the non-return valve assembly to each bank of heaters. The total kilowatt rating of the expansion control valves shall be no less than the total kilowatt rating of all the heaters in the bank.

5.11 MULTIPLE INSTANTANEOUS WATER HEATERS

The heated water piping from separate instantaneous water heaters shall not be connected into a common manifold unless recommended in the water heater manufacturer's installation instructions and manuals.

5.12 TEMPERATURE/PRESSURE-RELIEF AND EXPANSION-CONTROL VALVE DRAIN LINES

5.12.1 Size and material

For other than the expansion-control valve fitted to heat exchange water heaters, every temperature/pressure-relief valve and expansion-control valve shall be fitted with a drain line that shall—

- (a) be of copper or other suitable piping;
- (b) be of a diameter not smaller than the nominal size of the valve outlet; and
- (c) have a length in accordance with Table 5.4.

NOTE: It may be necessary to have the valve drain line discharge into a tundish when the distance to the point of final discharge is greater than the maximum given in the Table.

5.12.2 Interconnection of drain lines

5.12.2.1 Individual water heaters

The drain lines from the outlet of the temperature/pressure-relief valve and the expansion control valve on an individual water heater may be joined together subject to the following:

- (a) Interconnection is limited to the drain lines from the outlets of one temperature/pressure-relief valve and one expansion-control valve (see Clauses 5.8(c)(ii) and 5.10.3(b)).
- (b) Installation of the drain lines complies with Clause 5.12.3.

NOTE: Some regulatory authorities may not permit interconnection of drain lines.

TABLE 5.4
LENGTHS AND CHANGES OF DIRECTION

Maximum relief drain length m	Maximum numbers of changes of direction (greater than 45°)
9	3
8	4
7	5
6	6

5.12.2.2 Multiple relief valves

Except for drain lines complying with Clause 5.12.2.1, the drain lines from multiple relief valves shall not be interconnected, but may discharge over a tundish on a common drain line. The common drain line shall be sized in accordance with Clause 5.12.5.

5.12.3 Installation

Drain lines from temperature pressure-relief valves, expansion control valves and tundishes shall be installed as follows:

- (a) There shall be no tap, valve or other restrictions in any line.
- (b) Each line shall fall continuously from the valve to the point of discharge.
- (c) Drain lines from expansion control or temperature pressure-relief valves shall not discharge into a safe tray.
- (d) The point of discharge from each drain line shall be located so that the release of steam or hot water does not cause a nuisance, is readily discernible and incurs no risk of damage to the building or injury to persons.
- (e) Where a drain line terminates outside a building, the end of the line shall be—
 - (i) not lower than 75 mm or higher than 300 mm above an overflow relief gully or disconnector gully;
 - (ii) not lower than 75 mm or higher than 300 mm above a gravel pit not less than 100 mm in diameter;
 - (iii) over a tundish in accordance with Clause 5.12.3 (h); or
 - (iv) where authorized, not lower than 200 mm or higher than 300 mm above an unpaved surface.

NOTE: Where discharges from valves may adversely affect slabs and footings of buildings, the drain lines should discharge away from the building. Further guidance is provided in the BCA.

- (f) Where the drain line from the expansion control valve on a heat exchange water heater is directed into the water storage container, there shall be a minimum air gap of 20 mm, except where the valve and associated drain lines are supplied as an integral part of the water heater.
- A2

(g) Where a water heater is externally located, the drain line from the relief valve shall be terminated so as to discharge water away from the operator during operation of the valve.
- A2

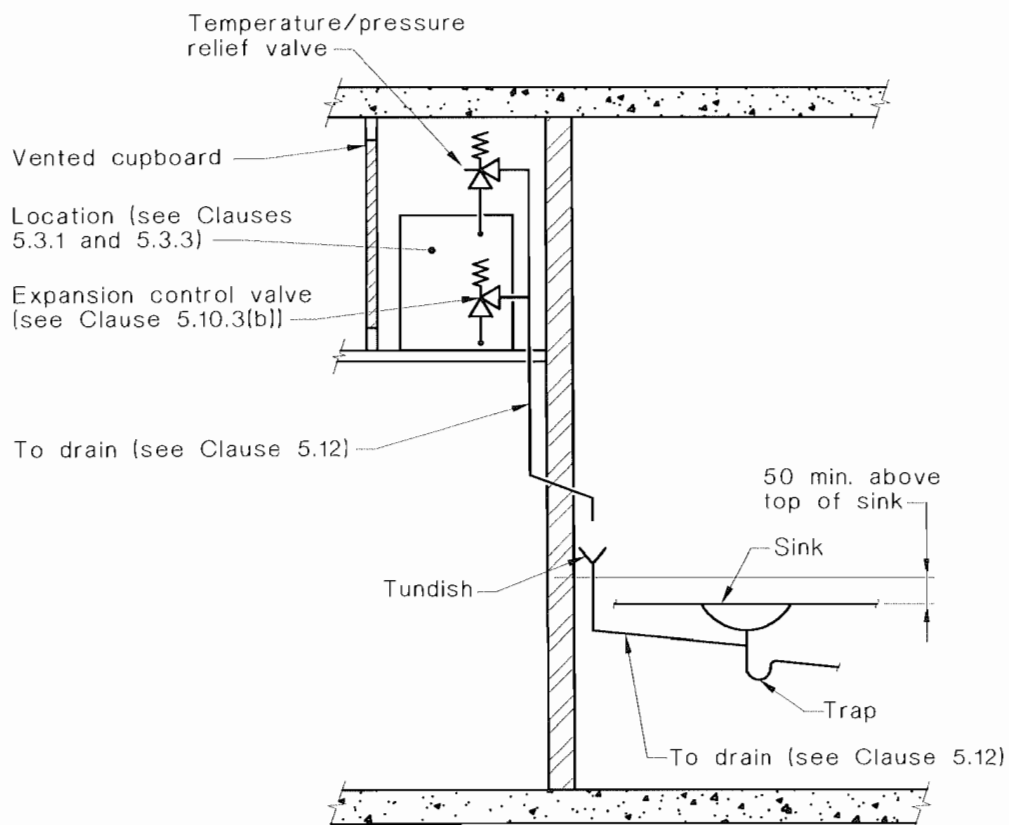
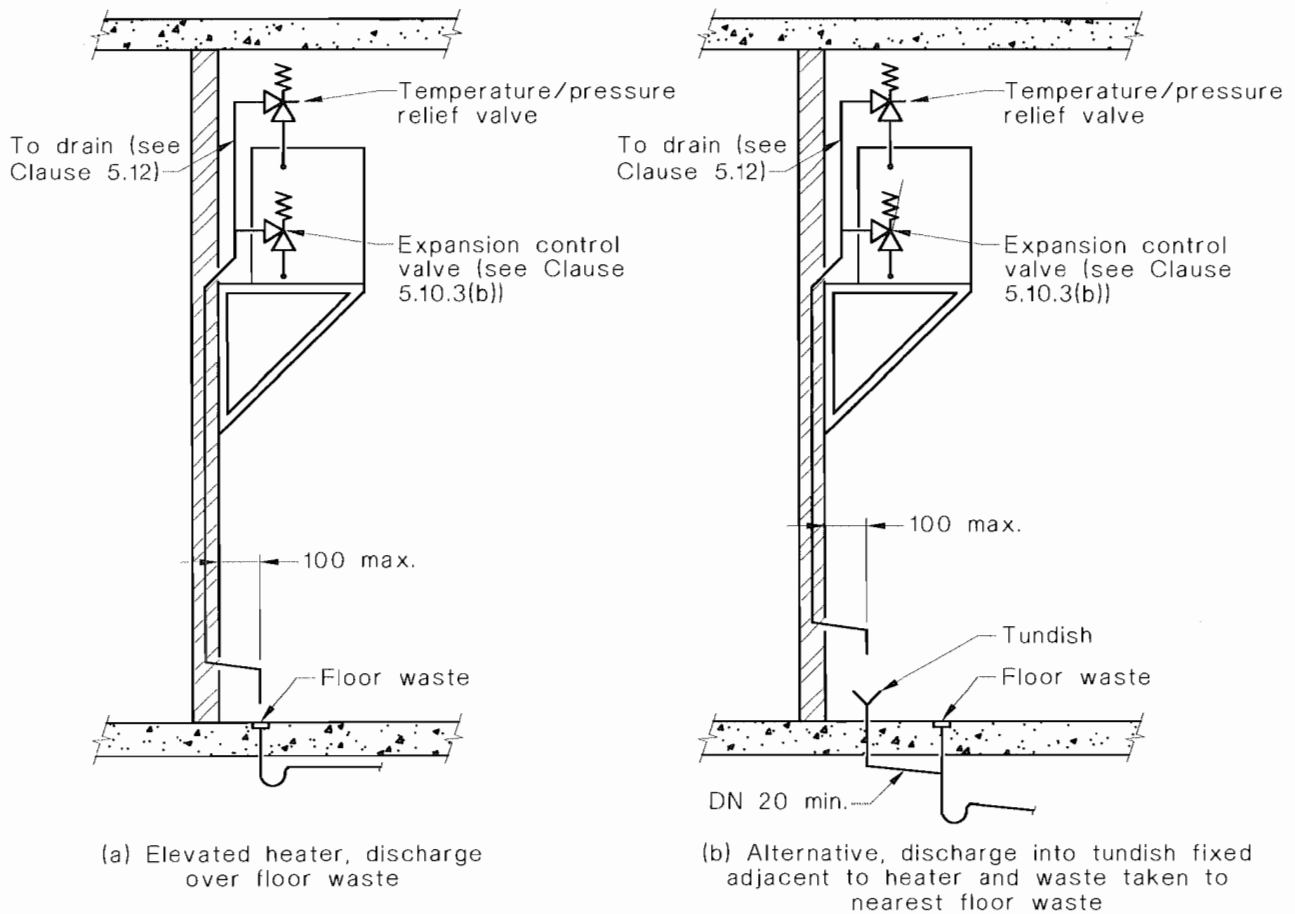
(h) Where discharging over a tundish or gully, drain lines shall have an air gap of a size at least twice the diameter of the drain line.
- A2

(i) Where permitted, plastics drain lines, shall be—

 - (i) continuously supported;
 - (ii) fixed and secured in accordance with Clause 4.5;
 - (iii) adequately protected from UV if exposed to direct sunlight; and
 - (iv) installed with a suitable allowance for thermal movement.

NOTES:

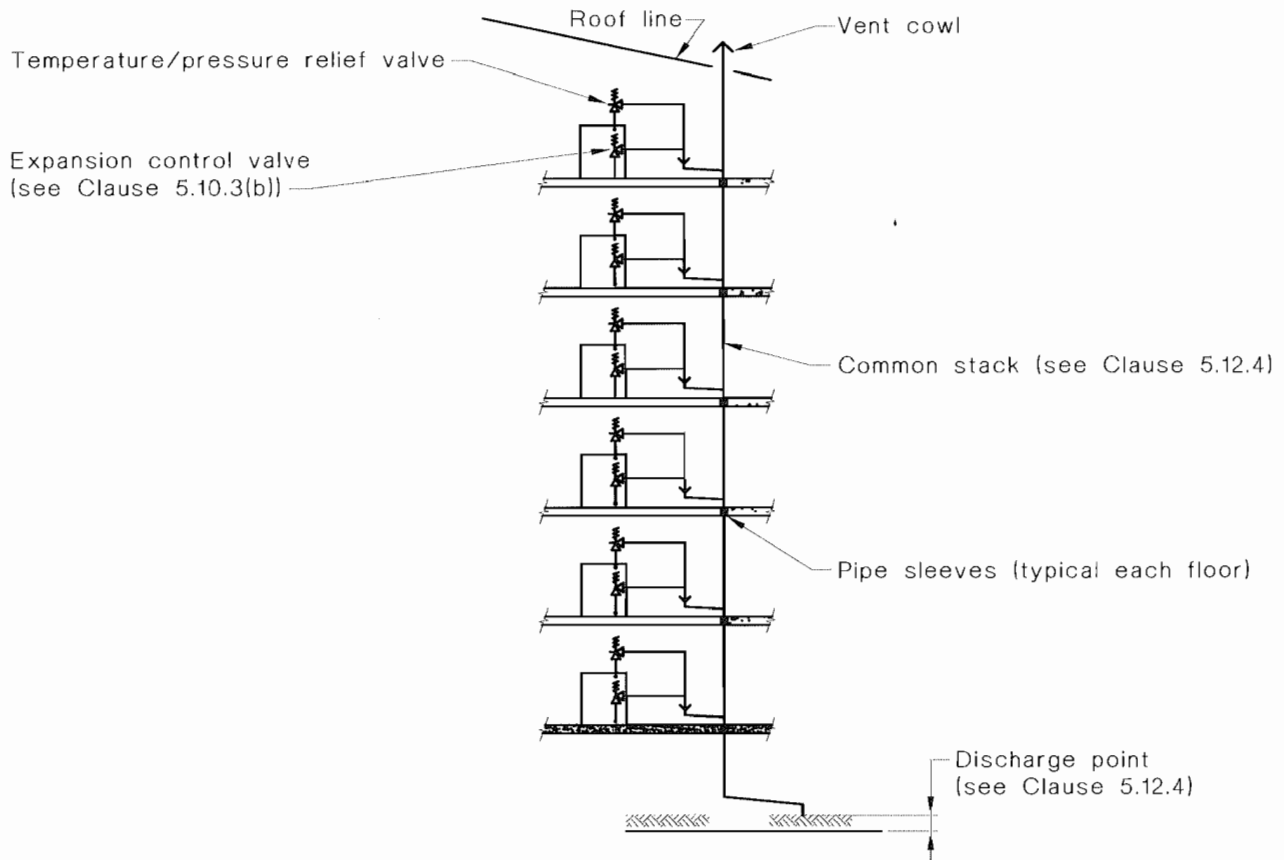
- 1 Typical installations of drain lines are illustrated in Figure 5.11 and Figure 5.12.
- 2 Ponding should be avoided



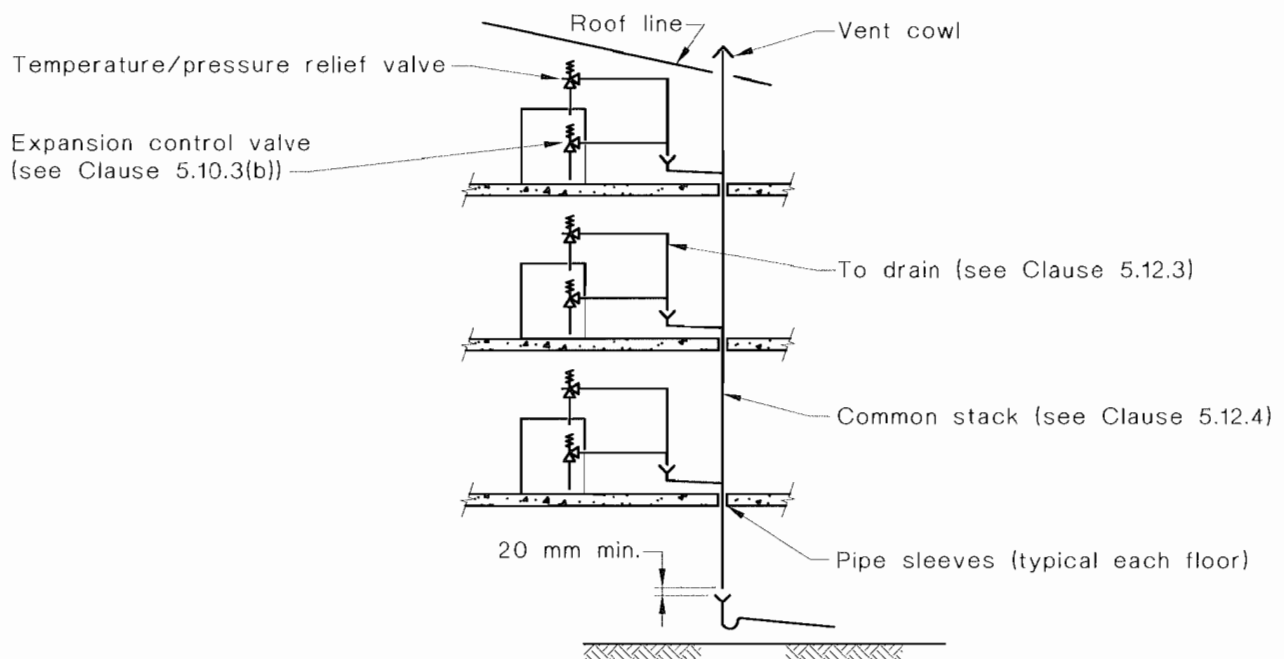
(c) Heater located in vented cupboard, discharge to kitchen sink waste

DIMENSIONS IN MILLIMETRES

FIGURE 5.11 TYPICAL RELIEF DRAINAGE



(a) Common stack discharge over ground, stormwater drain or gully



(b) Common stack discharge to a soil or waste stack

FIGURE 5.12 TEMPERATURE/PRESSURE-RELIEF VALVE DRAIN LINES—
COMMON STACK DISCHARGE METHODS

5.12.4 Common stack discharge

Where individual water heaters are installed in a multistorey building, the relief drain lines may discharge into a common stack, subject to the following:

- (a) The discharge from the common stack is to a tundish, having a discharge line, that is not less than the size of the common stack, directly connected to a fixture trap, and installed in connection with any adjacent soil or waste stack.
- (b) The discharge point of the common stack is such that any discharge is readily visible and not cause any nuisance.
- (c) The common stack is vented by extending the pipe upwards, above the roof level.

5.12.5 Tundish drain lines

A2

The drain line from any tundish shall be not less than one size larger than that of the largest drain line discharging into the tundish. Tundish drain lines shall comply with Clause 5.12.3.

5.12.6 Areas subject to freezing

In areas where water pipes are prone to freezing, the drain line from any valve shall be insulated and not exceed 300 mm in length. It shall discharge into a tundish through an air gap of not less than 75 mm and not more than 150 mm measured from the outlet of the drain line to the rim of the tundish.

5.13 VENT PIPES

5.13.1 Installation

5.13.1.1 Storage water heaters

Each vented storage water heater shall be fitted with a vent pipe of copper not smaller than DN 20 and shall—

- (a) have no tap, valve, sharp change of direction or other restrictions in the pipe;
- (b) rise continuously from the point of connection as specified by the water heater manufacturer; and
- (c) have any roof or wall penetration rendered waterproof with due allowance made for expansion.

5.13.1.2 Heat exchange water heaters and boiling water units

Vent pipes for heat exchange type water heaters and boiling water units shall be installed in accordance with the manufacturer's instructions.

5.13.2 Termination of vent pipe

Vent pipes installed on a water heater shall—

- (a) when over a cold water storage tank, be turned downward and discharged into the cold water storage tank by passing through the lid, finishing not lower than the outlet of the float valve and not discharging over the float valve assembly;
- (b) when taken through a roof, have the open end of the pipe point upwards or be turned downwards and if projecting more than 1 m above the roof, be supported (see Figure 5.8(b)); and
- (c) in locations subject to freezing conditions vent pipes should be insulated to at least 300 mm above the working water level.

5.13.3 Cold water storage tank-fed water heaters (other than side-fed types)

Vent pipes, when fitted in conjunction with a cold water storage tank, shall rise to a height not less than 80 mm above the static water level in the tank for every 1 m between the overflow water level in the feed tank and the base of the heater, or 300 mm, whichever is the greater.

5.13.4 Vented storage water heaters, inlet pressure-controlled

A vent pipe, when installed in conjunction with a water heater fitted with a pressure-reducing valve, shall either rise to a height above the outlet of the pressure-reducing valve in accordance with Table 5.5, or in accordance with the following equation:

$$H = \frac{SP}{10} + 1$$

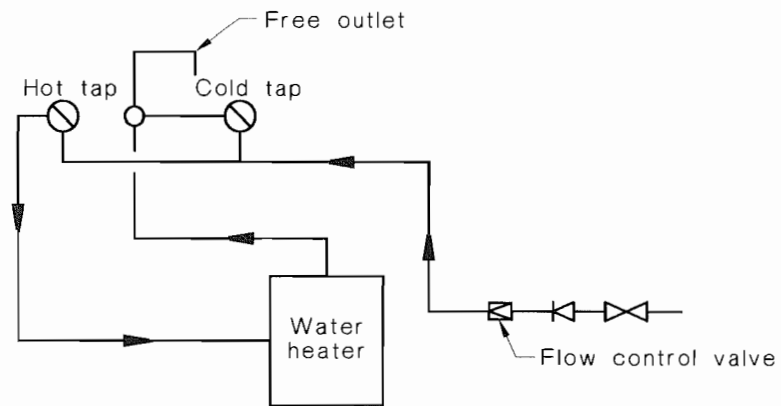
where

H = the height of vent pipe, in metres, to the nearest 0.5 m

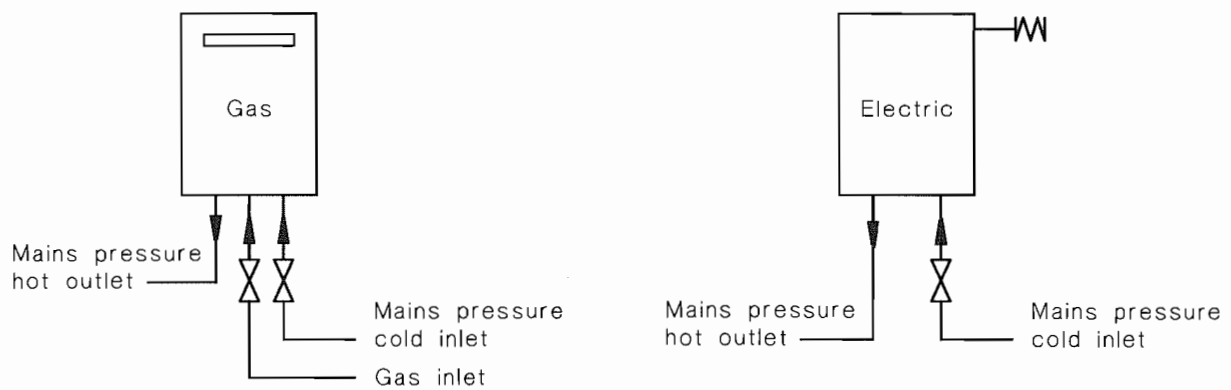
SP = set outlet pressure of the reducing valve, in kilopascals.

TABLE 5.5
HEIGHT FOR VENT PIPES ABOVE
A PRESSURE-REDUCING VALVE

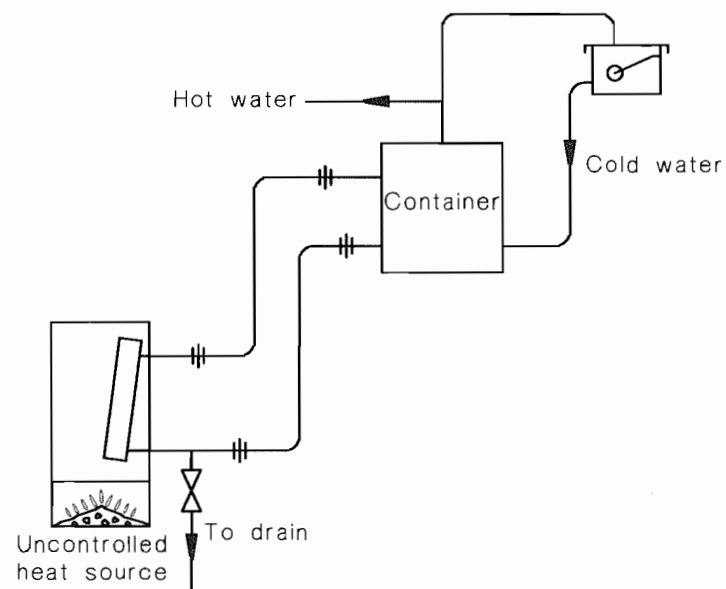
Pressure-reducing valve setting kPa	Height of vent pipe m
25	3.5
30	4.0
35	4.5
45	5.5
50	6.0
70	8.0



(a) Free outlet under-sink water heater



(b) Instantaneous water heater



(c) Uncontrolled water heater

FIGURE 5.13 TYPICAL WATER HEATER ARRANGEMENTS

SECTION 6 INSTALLATION OF SOLAR WATER HEATERS

6.1 SCOPE OF SECTION

This Section sets out requirements for the installation of solar water heaters. It covers systems with fixed orientation and inclination used either singly or in multiple-unit installations.

This Section is applicable to both thermosiphon and pumped systems, to both close-coupled (or integral) systems and systems with the container remote from the collectors, and to both rated and unrated systems. Requirements relating to the installation of supplementary heating (electricity, gas, liquid or solid fuel) are also specified.

6.2 APPLICATION OF SECTION (NEW ZEALAND ONLY)

In New Zealand reference shall be made to NZS 4613 and NZS 4614.

6.3 GENERAL

6.3.1 Performance

Environmental factors of solar radiation for the area, local considerations of dust, hail, frost, shade and wind, and the aspects of both the quality of water used and the consumer hot water usage habits will affect both the performance and the service life of the unit.

A2 | Systems rated in accordance with AS 2813, AS 2984, NZS 4613 or AS/NZS 4234 shall be installed strictly in accordance with the manufacturer's instructions and with the relevant sections of this Standard in order to ensure that the rated performance is achieved. The performance of unrated systems (typically those assembled from components of different manufacture) and of forced circulation systems (where the water is circulated through the solar collector by means other than thermosiphon action) are particularly dependent upon compliance with this Section.

NOTES:

- 1 For recommendations for the installation of unrated solar hot water supply systems, see Appendix F.
- 2 For recommendations for the installation of close-coupled and integral solar systems, see Appendix G.

Basic reference data are included in this Section to provide information to assist in the choice of a suitable system.

6.3.2 Solar water heater

Solar water heaters shall be installed in accordance with the manufacturer's instructions and this Standard.

6.3.3 Location

The location of solar water heaters shall comply with Clause 5.3.

6.3.4 Sizing

A2 | Installing smaller systems will result in reduced performance. The performance of particular systems configurations and installations can be estimated from the requirements of AS/NZS 4234.

NOTE: For manufacturer's instruction and domestic sizings see Appendix H.

6.4 INSTALLATION OF SOLAR WATER HEATER CONTAINER

6.4.1 Solar water heater containers

Solar water heater containers shall comply with the relevant Standard.

6.4.2 Containers installed on or above a roof

6.4.2.1 Support

The containers of close-coupled or integral systems mounted directly onto a roof structure shall be positioned so as not to compromise the structural integrity of the roof.

Separately located containers shall be supported on a platform. The platform shall comply with Clause 5.5.2.

NOTES:

- 1 For recommendations for the installation, see Appendix G.
- 2 Structural engineering calculations may be required.

6.4.2.2 Protection of externally mounted containers

Containers installed externally shall comply with Clause 5.6.

6.4.2.3 Containers installed in a roof

Containers installed in the roof and their support shall comply with Clause 5.5.1.

6.4.2.4 Protection against damage from leaking water

Containers shall be installed in accordance with the requirements of Clause 5.4.

6.4.2.5 Connection to containers

Unions shall be provided for the connection of any service pipes to the inlet and outlet of the container.

6.4.2.6 Pressure relief and venting of containers

Containers shall be provided with vents or relief devices in accordance with Clause 5.8.

6.4.3 Valves

Valves used in the installation of containers shall comply with Clause 5.9. Unvented containers with the heat exchanger between the solar and storage circuits shall comply with the requirements of AS/NZS 2712 or NZS 4613 and NZS 4614.

6.4.4 Relief and expansion valve drain lines

Relief valves and expansion control valves shall be provided with drain lines that comply with Clause 4.12.

6.4.5 Vent pipes

Vented containers shall be provided with vent pipes that comply with Clause 5.13.

6.4.6 Supplementary heating connections

Additional external supplementary energy or heated water supply input may be connected to a solar water heater provided the following conditions are met:

- (a) Only connection points in the container or fittings or components supplied by the manufacturer are used and the connections are made in accordance with the manufacturer's instructions.
- (b) The temperature/pressure-relief valve or expansion control-valve complies with Clause 5.9.

- (c) The manufacturer has indicated that addition of the remote supplementary heat source is appropriate.
- (d) The installation of supplementary heating by uncontrolled heat sources complies with Clause 7.3.
- (e) For systems with remote containers, supplementary heating connection is made only into the primary circuit flow and return lines in accordance with the manufacturer's instructions.
- (f) For systems with forced primary circulation, the primary circulating pump is resized accordingly.

6.5 INSTALLATION OF COLLECTORS

6.5.1 Positioning

6.5.1.1 Shade

Collectors should be located so as to be clear of shade for 3 h either side of solar noon at any time during the year (i.e. nominally 9 a.m. to 3 p.m. standard time). Partial shading by small objects, such as chimneys, flues and TV antennas, is permissible during this period.

NOTE: A means of estimating the extent to which a collector will be shaded from the sun by buildings, roofs, trees, or some other obstructions is given in Appendix I.

6.5.1.2 Relative to container

Placement of collectors relative to the container shall be in accordance with the manufacturer's instructions.

Where no specific recommendation for location is made in the manufacturer's instructions, the collectors shall be placed as close as is practicable to the container. For thermosiphon systems where the collector is remote from the container, the top of the collectors shall be not less than 150 mm (measured vertically) below the bottom of the container.

6.5.1.3 Orientation

Collectors shall be oriented according to manufacturer's instructions.

NOTE: Examples of orientation are given in Appendix J.

6.5.1.4 Inclination

Collectors should be inclined at a similar angle to the latitude angle. The deviation from this angle should be not greater than $\pm 20^\circ$.

For thermosiphon systems, the minimum allowable inclination angle shall be 10° , unless specifically recommended by the manufacturer for a lesser angle.

NOTE: For data on the effect on system performance of changes in angles of orientation and inclination for typical systems at various installation locations, see Appendix J.

Generally, improved winter performance and lower mean water temperature through the collector are obtained by an angle of inclination greater than the latitude angle while improved summer performance is obtained from an angle of inclination less than the latitude angle.

For installations south of the Tropic of Capricorn (i.e., latitude greater than 23.5°S) in which the collectors cannot be oriented within 60° from true north, an inclination of between 10° and 20° from horizontal is recommended. For installations in the tropics, a collector inclination of between 10° and 20° is recommended irrespective of collector orientation.

6.5.1.5 Provision for removal of collector

Collectors shall be installed with union assemblies or compression fittings to permit removal without disturbing adjacent piping or collectors (see Clause 5.3.2).

6.5.2 Mountings

6.5.2.1 Manufacturer's instructions

Collectors shall be erected and mounted strictly according to the manufacturers' instructions. Where mountings are supplied by the manufacturer, they shall be used without alteration unless otherwise permitted by the manufacturer.

6.5.2.2 Method of mounting

Individual collectors shall be mounted either directly to the roof structure or to a suitably designed frame fixed to the roof structure, and shall not rely on pipe connections for structural strength (see Figure 6.1).

Provision shall be made in all installations to ensure drainage either under or over the collector, and the collector shall be arranged so as not to trap rainwater or debris (see Figure 6.2).

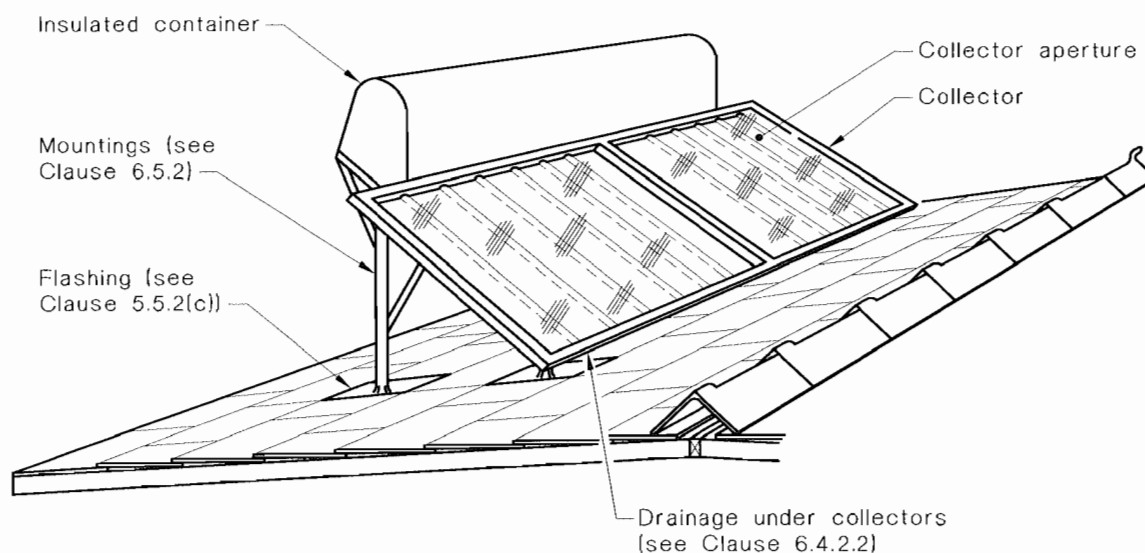


FIGURE 6.1 CLOSE-COUPLED SOLAR WATER SYSTEM
(AGAINST-PITCH INSTALLATION SHOWN)

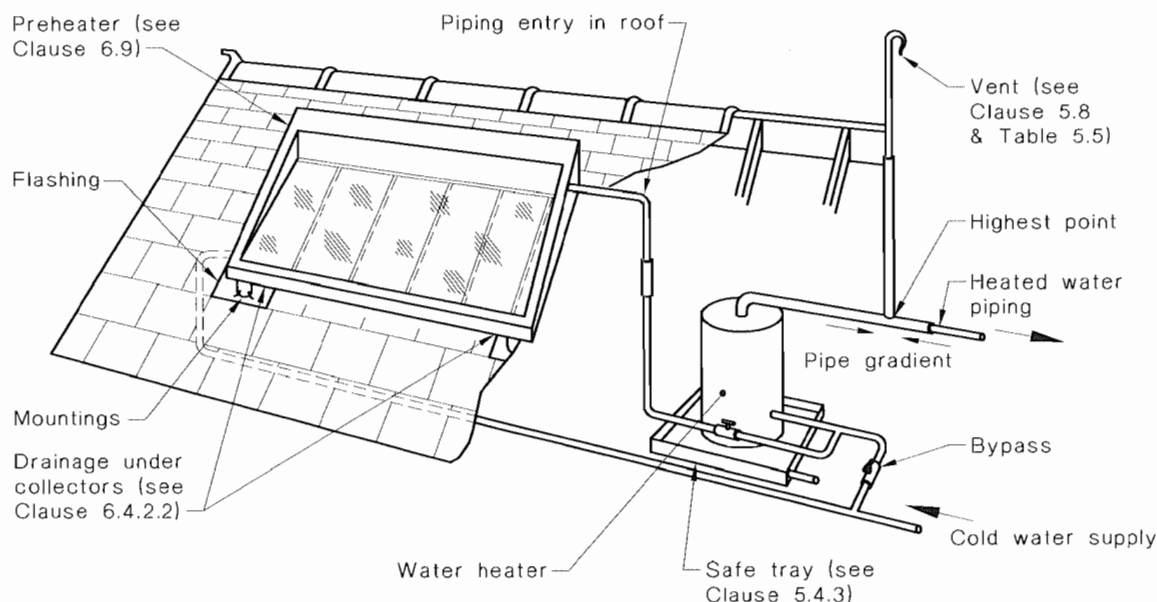


FIGURE 6.2 SOLAR PREHEATER TO EXISTING WATER HEATER
(REDUCED PRESSURE SYSTEM SHOWN) (ILLUSTRATIVE ONLY)

6.5.3 Precautions

6.5.3.1 Frost-prone areas

Collectors that are marked, '*not suitable for frost areas*', shall be used in frost-prone areas only if fitted with a frost protection system or device (see AS/NZS 2712 or NZS 4613 and NZS 4614).

6.5.3.2 Water salinity

Where the total salinity of the water exceeds 500 mg/L, the collectors shall be of a type that is labelled by the manufacturer as suitable for use with water of equal or greater salinity (see Clause 1.6).

6.5.3.3 Water hardness

Where the total hardness of the water exceeds 150 mg/L, expressed as calcium carbonate (CaCO_3), the collectors shall not be charged with water until required for use, and shall be shaded by an effective cover during the interim period. The customer should be advised to use an effective cover during periods of minimum hot water use.

6.5.3.4 Cyclonic areas

Only collectors and mounting systems endorsed by the manufacturer and approved by local authorities as suitable shall be installed in cyclonic areas.

NOTE: For wind speeds, see Appendix K.

6.5.3.5 Hail-prone areas

In areas where hailstones in excess of 15 mm diameter are experienced, collectors shall be—

- designated by the manufacturer as being hail resistant complying with the requirements of AS/NZS 2712 or NZS 4613 and NZS 4614; or
- fitted with suitable hail guards.

6.6 INSTALLATION OF CLOSE-COUPLED AND INTEGRAL SOLAR WATER HEATERS

6.6.1 General

Containers and collectors of close-coupled and integral solar water heaters shall be installed in accordance with Clauses 6.3 and 6.4, respectively.

6.6.2 Roof mountings and supports

Close-coupled or integral solar water heaters shall be supplied complete with correctly designed roof-mounting frames, brackets, fixings, and similar parts, as required, to correctly install the systems. The solar water heater and components shall be certified as suitable for the location and type of installation 'with-pitch', 'against-pitch' or 'cross-pitch' (see Figures G1, G2, and G3, Appendix G). Due regard shall be paid to mounting height above ground level, direction and speed of prevailing winds anticipated in cyclonic areas and earthquake risk.

All straps used in the support or fastening of close-coupled or integral systems shall be hot-dip galvanized after fabrication. Alternatively, a suitable corrosion-resistant alternative may be used.

Structural members that penetrate the roof shall be flashed or rendered watertight in such a manner as will allow for expansion and be appropriate to the construction. Fastening holes shall be weather sealed.

NOTE: Close-coupled or integral solar water heaters mounted on roofs should be installed in accordance with Appendix G.

6.7 THERMOSIPHON FLOW SOLAR WATER HEATERS WITH REMOTE CONTAINERS

6.7.1 General

Installation of containers and collectors of thermosiphon flow water heaters with remote containers shall be in accordance with Clause 6.3 and 6.4 respectively (see Figure 6.3). All interconnecting piping shall be in accordance with Section 3.

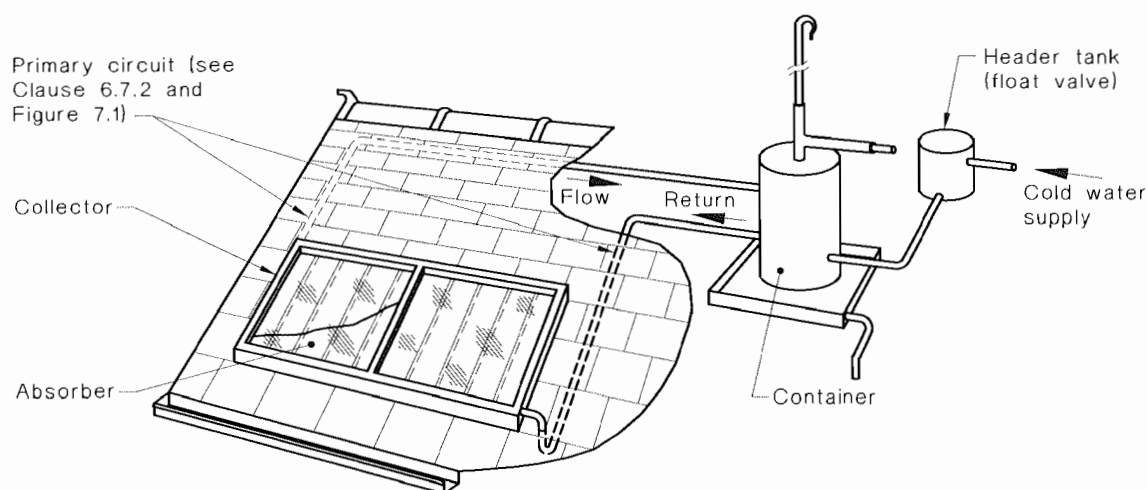


FIGURE 6.3 THERMOSIPHON SYSTEM WITH REMOTE CONTAINER

6.7.2 Primary circuit flow and return pipes—Pipes and fittings

All piping used for the conveyance of hot drinking water to or from the collector to the container shall be of a type, under the likely maximum temperature and pressure conditions of use, not inferior to copper pipe.

6.8 SOLAR WATER HEATERS WITH FORCED PRIMARY CIRCULATION

6.8.1 General

Containers and collectors of solar water heaters with forced primary circulation shall be installed in accordance with Clause 6.3 and 6.4 respectively. All plumbing shall be in accordance with Section 3 (see Figure 6.4).

Circulating pumps and controllers supplied with, or as an integral part of, an approved water heater shall be installed in accordance with the manufacturers' instructions. Where circulating pumps and controllers are not supplied as an integral part of an approved water heater, they shall be selected and installed in accordance with Clause 6.8.2.

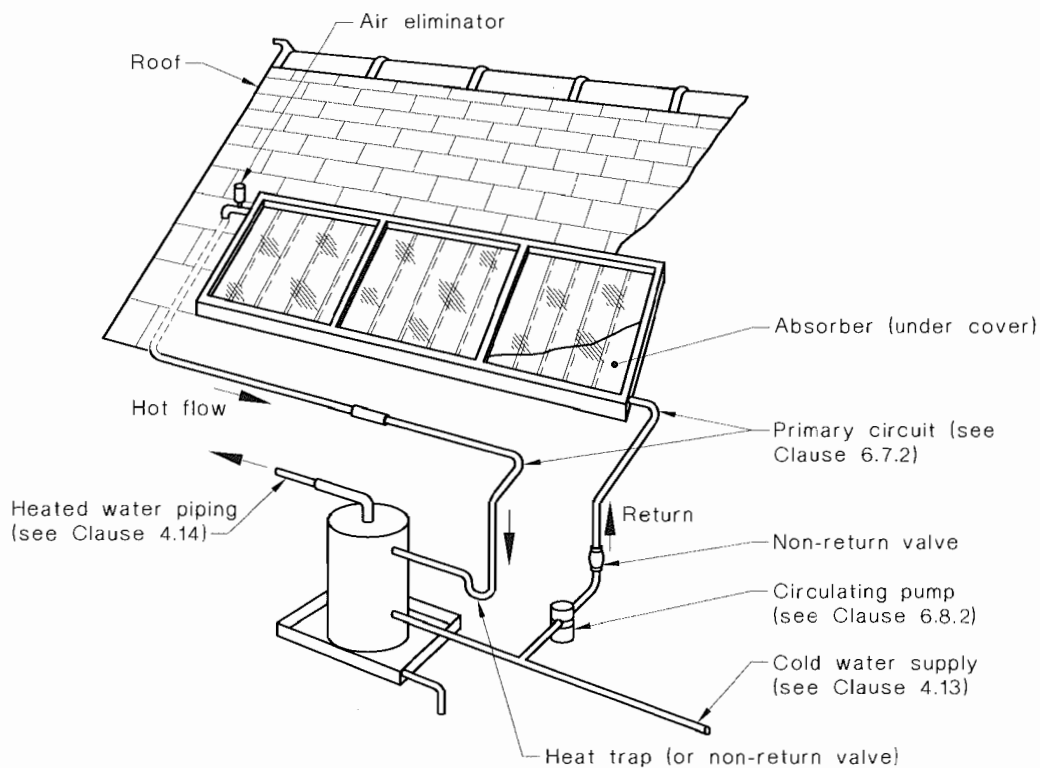


FIGURE 6.4 FORCED CIRCULATION

6.8.2 Primary circulation pump

6.8.2.1 Construction

Where a circulating pump is installed and connected to circulate water through the system, any copper alloy materials in contact with water shall be dezincification resistant (DR). Where non-metallic materials are used, these shall perform adequately in respect of erosion, corrosion, contamination and mechanical properties when the system is operated at the most extreme temperature conditions.

6.8.2.2 Capacity

The capacity of the pump shall be suitable for the number of collectors in accordance with the manufacturer's recommendations. In the absence of such information a capacity of 10 to 20 L/h per m² of collector area is appropriate. This will normally provide a temperature rise across the collector of about 25°C to 30°C under high irradiance.

NOTE: For large installations of forced circulation systems, the system design should be undertaken by a competent designer or be referred to the collector or container manufacturer for design assessment.

6.8.2.3 Pump and controller installation

The pump and controller installation shall comply with the following requirements:

- (a) The primary circulating pump shall be installed to draw the colder water from the lower section of the container and to circulate this water through the collectors before returning it to the container.
- (b) Only connection points in the container or in fittings or components, supplied by the manufacturer, shall be used for the cold water supply from the container and hot water return to the container. The connections shall be made strictly in accordance with the manufacturer's installation instructions.
- (c) Where the primary circulating pump is mounted separately from the container, the pump shall be rigidly supported on a properly designed base or frame and the piping system arranged so that no perceptible vibration is transmitted to either the collector or the building.
- (d) Circulating pump controls shall be fitted and connected in an accessible position in accordance with the manufacturer's installation instructions.
- (e) Where electronic temperature probes are used, the contractor shall ensure the probe pocket is free of moisture before the probe is inserted and that the pocket is protected against moisture entry after the probe is fitted.
- (f) A warning notice on voltage used and a control wiring diagram shall be affixed to the inside of the control box cover and the fuse box, together with identification of control components fitted and the name of the supplying agents.

6.9 SOLAR WATER HEATERS USED AS PREHEATERS

6.9.1 General

Solar water heaters, installed as preheaters, shall comply with the relevant requirements of this Standard. The capacity of a preheated water storage cylinder should be capable of providing one day's supply of hot water.

NOTE: Outline details of typical preheater installations are provided for reference in Figures 6.2, 6.5, 6.6, and 6.7.

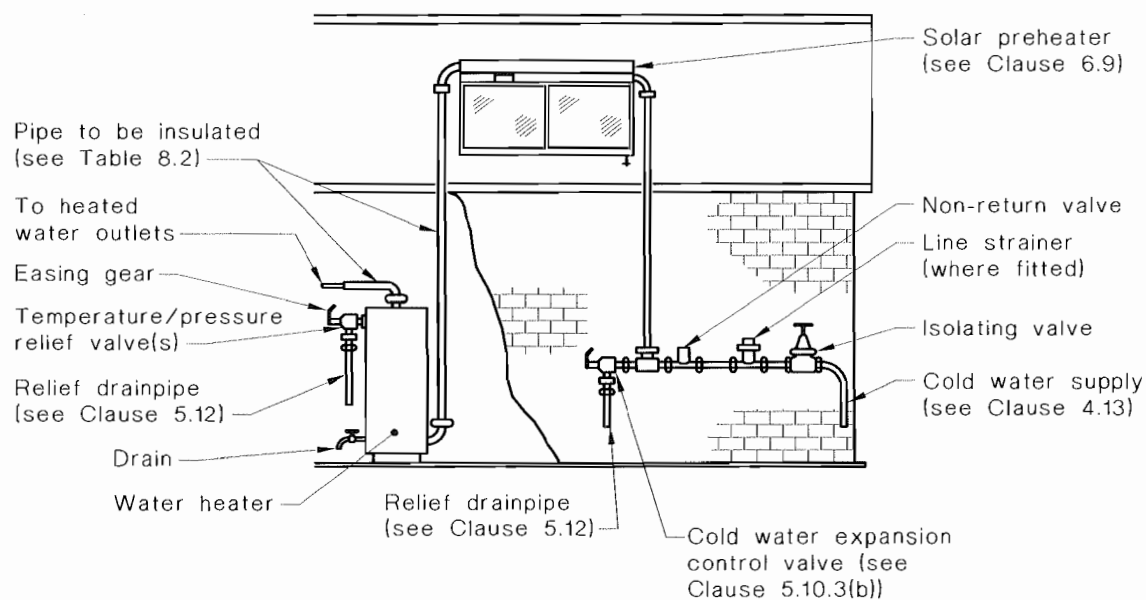


FIGURE 6.5 INSTALLATION OF UNVENTED (VALVE VENTED) WATER HEATER WITH SOLAR PREHEATER

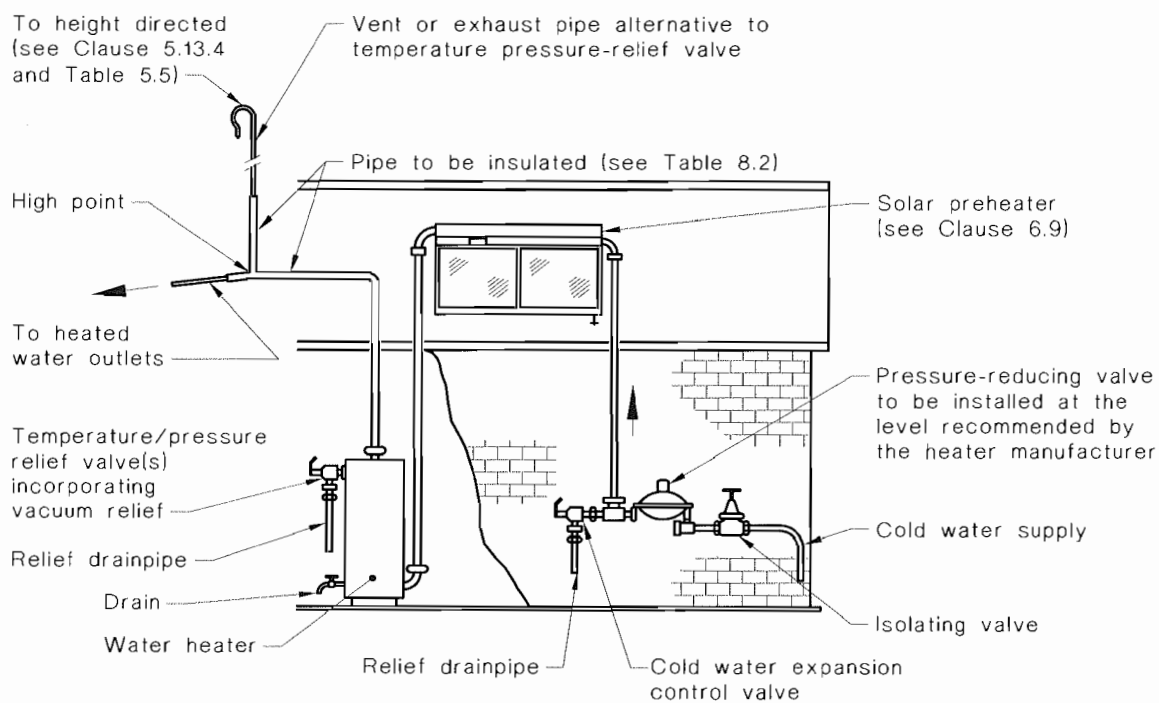
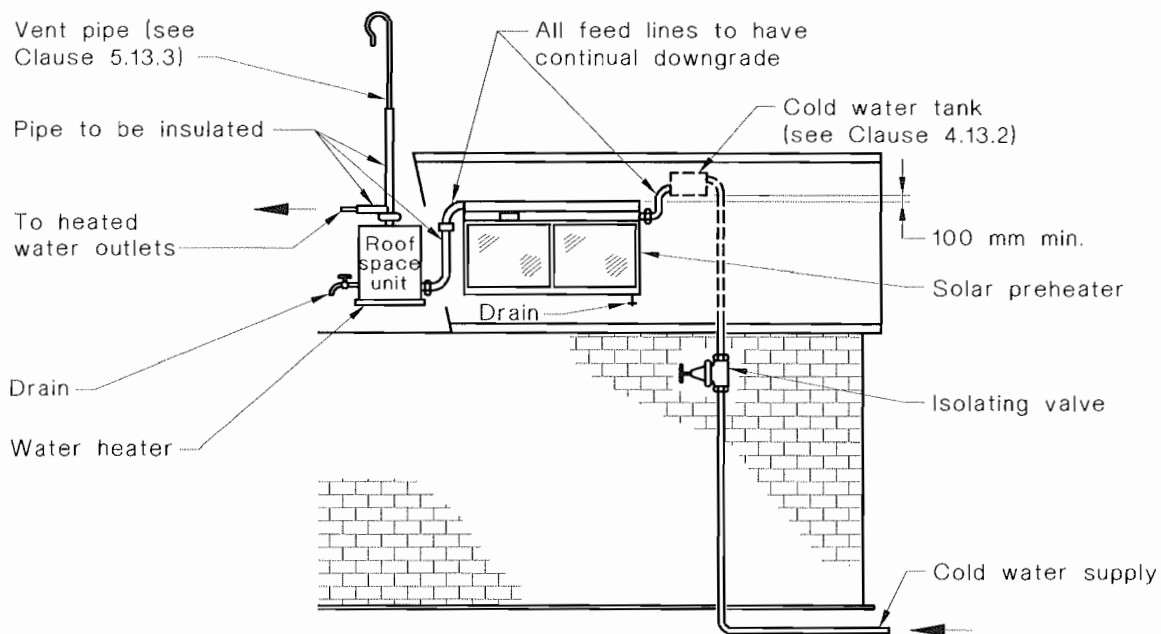


FIGURE 6.6 INSTALLATION OF OPEN-VENTED WATER HEATER WITH SOLAR PREHEATER CONTROLLED BY PRESSURE-REDUCING VALVE

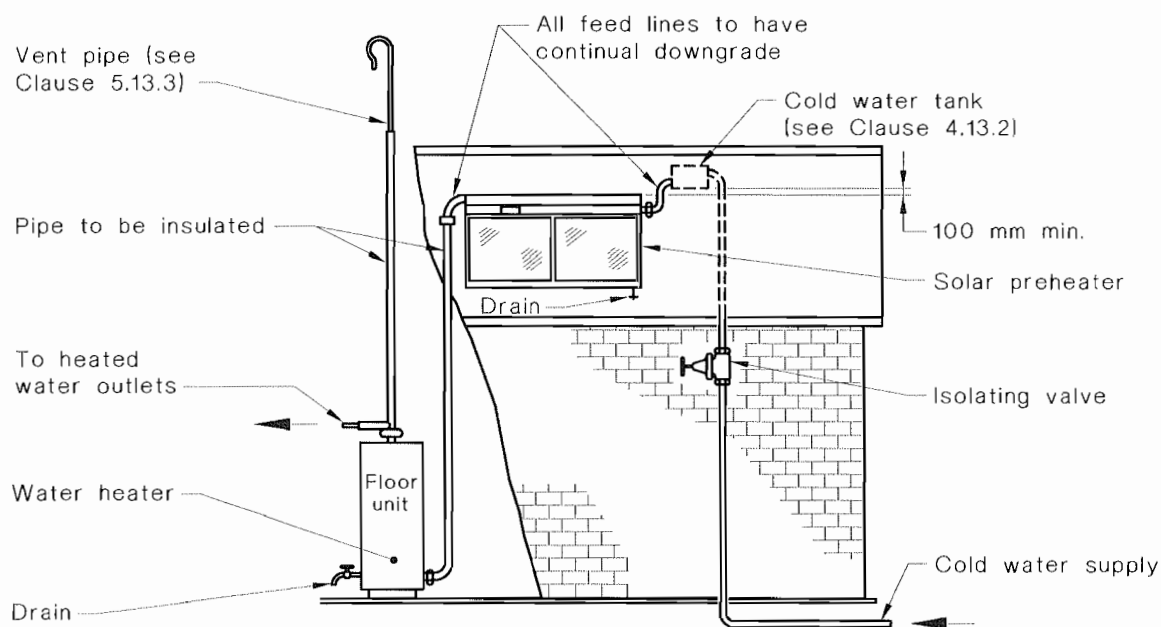
6.9.2 Installation of solar preheaters—Cold water storage tank-fed water heaters

For a cold water storage tank-fed water heater, the solar preheater shall be installed between the cold water feed tank and the water heater, accordance with Clauses 6.3 and 6.4. All plumbing shall be in accordance with Section 3.

NOTE: A typical installation is shown in Figure 6.7.



(a) Unit in roof space



(b) Unit on floor

FIGURE 6.7 INSTALLATION OF COLD WATER STORAGE TANK-FED WATER HEATERS WITH SOLAR PREHEATER

6.9.3 Installation of solar preheaters—Mains pressure and reduced-pressure water heaters

6.9.3.1 *New buildings installation*

Where a solar preheater is installed in a new mains pressure or reduced-pressure hot water service, the installation shall comply with Clauses 6.3 and 6.4. The cold water supply controls and the expansion control valve shall be installed prior to the solar preheater.

NOTE: Typical installations are shown in Figures 6.5 and 6.6.

6.9.3.2 *Existing systems installation*

Where a solar preheater is to be installed in an existing mains pressure or reduced-pressure hot water service, the installation requirements shall be in accordance with Clause 6.8.3.1. Where the existing service is fitted with an expansion control valve on the cold water inlet side, the expansion control valve shall be refixed on the inlet to the preheater as shown in Figures 6.5 and 6.6.

6.9.3.3 *Suitable types of existing heaters*

Solar preheaters shall only be connected in series with household water heaters that incorporate a thermostatic control. Household water heaters, which do not incorporate approved thermostatic control, shall only be connected to a solar preheater in a parallel circuit via a changeover valve. In such cases, the solar preheater shall act as an alternative summer heat source only and not as a permanent preheater.

Where the solar preheater is not permanently connected into the heater unit system, the preheater shall be fitted with a relief valve as required for containers (see Clause 5.8).

6.10 MULTIPLE SOLAR WATER HEATERS INSTALLATIONS

6.10.1 General

Multiple solar water heaters shall be installed in accordance with Clause 5.10.

In systems with a large number of units, unbalanced flow may lead to uneven temperature rises through individual units. The advice of an hydraulic engineer designer is recommended in these cases.

6.10.2 Thermosiphon systems—Series connection

Series or series/parallel connections of solar water heaters shall be acceptable.

Each series line shall be fitted with a full-way isolating gate or ball valves to enable that line to be isolated from the system for maintenance.

Close-coupled solar water heaters should be connected in series only where recommended by the manufacturer.

6.11 SUPPLEMENTARY HEATING

6.11.1 Thermal capacity

Supplementary heating equipment shall have sufficient thermal capacity to supply normal heated water requirements in its own right in order to supply enough heated water in cloudy conditions.

6.11.2 Drain connection

Supplementary heating, incorporating a heating coil or similar heat exchange facility, shall be provided with a drain connection to allow the replacement of components with the minimum of water spillage (see Clause 7.3.3).

SECTION 7 ENERGY SOURCES

7.1 SCOPE OF SECTION

This Section specifies requirements for the energy sources required to be connected to a water heater.

7.2 CONTROLLED ENERGY SOURCES

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Electric supply *The electrical installation has to comply with AS/NZS 3000 and the local electricity supply authority requirements.*

The local electricity supply authority should be consulted prior to commencing work to determine if a suitable electricity supply is available.

Gas-fired water heater installations *In addition to the requirements of this Standard, the installation of a gas-fired water heater and its fluing, ventilation and gas piping has to comply with AS 5601 or NZS 5261 and the manufacturer's instructions.*

The local gas utility should be consulted before commencing work to determine if or when gas can be supplied, or the suitability of the existing gas supply to meet the required demand.

7.3 WATER HEATERS WITH UNCONTROLLED ENERGY SOURCE

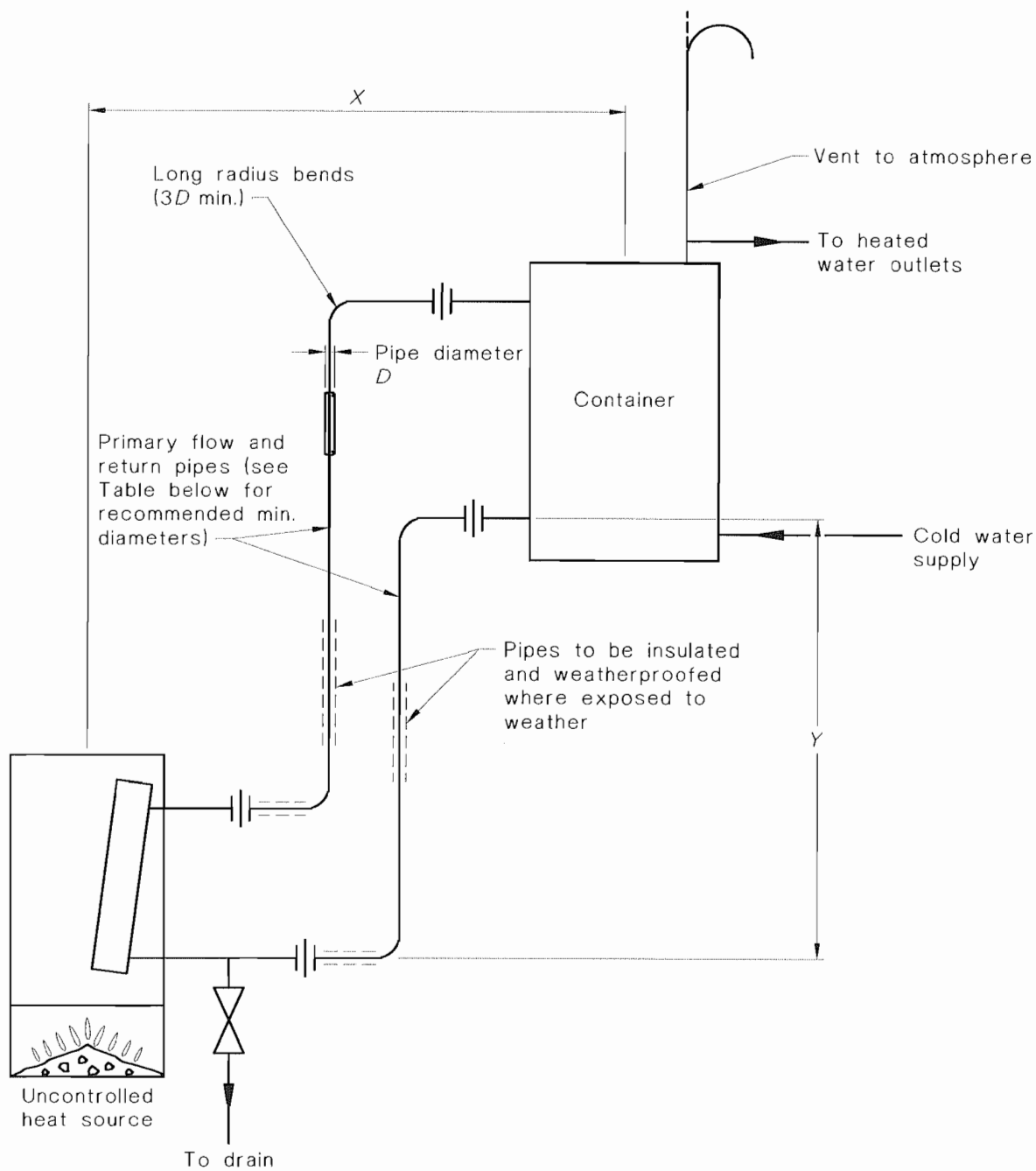
7.3.1 Installation

The installation of water heaters with an uncontrolled heat input shall comply with the following:

- (a) Thermosiphon water heaters connected to slow combustion stoves or room heaters with water-heating coils, wetback boilers, or the like, shall—
 - (i) have no valves fitted or connected to the primary flow and return pipes between the water heater and the heat source;
 - (ii) have the primary flow and return pipes of a minimum nominal diameter relative to the length, as given in Figure 7.1;
 - (iii) have the primary flow and return pipes rise or fall in a continuous gradient;
 - (iv) have the primary flow and return pipes insulated so as not to present a hazard and, where exposed to the weather, have the insulation waterproofed;
 - (v) have the primary flow and return pipes installed in accordance with Figure 7.1;
 - (vi) have no dissimilar metals in the primary flow and return lines;
 - (vii) have no elbows fitted in or to the primary flow and return lines; and
 - (viii) have the flow and return line connections made only with unions or similar-type couplings.

- (b) Thermosiphon water heaters described in Item (a), and direct-fired water heaters, shall—
- (i) be vented to atmosphere with a vent pipe in accordance with Clause 5.13, as appropriate;
 - (ii) be installed so that the maximum working pressure measured at the base of the water container does not exceed 50 kPa; and
 - (iii) be fitted with a tempering valve.

NOTE: For the purpose of this Clause, solar hot water systems fitted with a thermosiphon arrester, a heat dump valve, or a differential pump controller with a high limit cut-out are considered as having a controlled heat source.



Y m	Minimum nominal diameter, DN				
	X, m				
	2	4	6	8	10
1	20	20	25	32	32
2	20	20	25	32	32
3	20	20	20	25	32
4	18	20	20	25	25
5	18	20	20	20	25
6	18	18	20	20	25

NOTE: Dimensions X and Y are true horizontal and vertical distances, respectively.

FIGURE 7.1 PIPE COORDINATES: THERMOSIPHON SYSTEMS

7.3.2 Supplementary external heating

Supplementary heating connection shall not be made into the primary circuit flow or return piping without the manufacturer's specific approval. The installation shall be completed to the manufacturer's requirements with the primary circulating pump re-sized accordingly.

7.3.3 Provision for drainage

A drain point to which a hose may be readily attached shall be provided at the system's lowest point.

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SECTION 8 WATER AND ENERGY EFFICIENCY

8.1 SCOPE OF SECTION

This Section specifies water and energy efficiency requirements for heated water installations.

In Australia, it applies to installations serving all classes of buildings.

In New Zealand, it applies to all systems supplying hot water to sanitary fixtures except where individual storage vessels exceed 700 L in capacity.

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NOTES:

- 1 This Section does not apply to central heating systems. Provisions for insulation for central heating water piping are included in the BCA Vol. 2, Housing Provisions.
- 2 The provisions in this Section are to assist in the reduction of greenhouse gas emissions by arranging heated water service to efficiently use energy.

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8.2 THERMAL INSULATION

8.2.1 Piping associated with storage water heaters

Piping shall be thermally insulated to achieve a minimum R-value, as given in Table 8.1 for the climate regions identified in Figure 8.2 (Figures 8.2 (A) to 8.2 (G) show the climate regions for each state and territory) and Appendix L for Australia and Figure 8.3 and Appendix M for New Zealand, as follows:

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- (a) The inlet and outlet pipes, including valves, for a storage water heater, for at least the first 500 mm or, where an external heat trap is fitted, to a point 150 mm down the heat trap vertical leg closest to the water heater.

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- (b) All relief valves fitted directly to a storage water heater.
- (c) The primary flow and return pipes, including valves, between an auxiliary heater and a storage water heater.
- (d) All vent pipes to 300 mm above the maximum operating water level of the heated water system.

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- (e) On multiple installations, the whole heated water manifold, including valves, to a point at least 500 mm past the heated water outlet branch from the last water heater.
- (f) On a solar water heater installation, the pipework between a solar pre-heater and an in-line supplementary water heater.

The insulation installed in accordance with the above shall be installed so as not to impede the operation of the valves.

NOTES:

- 1 Care should be taken to ensure the continuity of insulation at wall and roof penetrations. Insulation should be carried through roof penetrations into the ceiling area.
- 2 In New Zealand, refer to Approved Document H1/AS1 and NZS 4305.
- 3 All exposed heated and cold water piping to and from externally mounted water heaters in frost-prone areas may require additional insulation to prevent freezing.

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- 4 'Text deleted'

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TABLE 8.1
MINIMUM THERMAL INSULATION—PIPING ASSOCIATED
WITH STORAGE WATER HEATERS

	Internal locations	External locations			
	All climate regions	Climate region A	Climate region B	Climate region C (*except alpine areas and as in Note 3)	Climate region C alpine areas (see Note 4)
Pipes	0.3	0.3	0.6	0.6*	1.0
Valves	0.2	0.2	0.2	0.2	0.2

NOTES:

- 1 An external location of a building is an unenclosed area and includes—
 - (a) an open sub-floor area of a building; and
 - (b) the area of a building located under an open veranda or carport.
- 2 The total R-values in Table 8.1 may be achieved for most heated water piping materials by using the following insulation:
 - (a) 9 mm of closed cell polymer, R = 0.2
 - (b) 13 mm of closed cell polymer, R = 0.3
 - (c) 25 mm of closed cell polymer, R = 0.6
 - (d) 38 mm of closed cell polymer, R = 1.0
- 3 Where the length of the piping to or from the water heater is exposed in an external location for more than 1 m, the minimum thermal insulation in Region 'C' shall be R 1.0.
- 4 Alpine areas are areas in NSW, ACT and Victoria higher than 1200 m above Australian Height Datum, and in Tasmania higher than 900 m above Australian Height Datum.

8.2.2 Other piping for heated water systems

Heated water system piping shall be thermally insulated in accordance with Table 8.2.

Where piping is required to be thermally insulated, valves in the line of pipe shall be insulated to a minimum total R-value of 0.2.

NOTE: See Note 2 (a) Table 8.1.

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TABLE 8.2
MINIMUM THERMAL INSULATION—HEATED WATER PIPING

System	Location of piping to be insulated	Minimum total R-values		
		Climate region A	Climate region B	Climate region C
Non-circulating heated water piping	All heated water piping that is buried or is within a conduit encased within a concrete floor slab	0.3	0.3	0.3
	All external piping from the water heater to the primary kitchen sink	0.3	0.6	1.0
	All external piping with trace heating including 500 mm along any branch off the trace-heated line	0.3	0.6	1.0
	All internal piping with trace heating, including 500 mm along any branch off the trace-heated line	0.3	0.3	0.3
Circulating heated water piping	All heated water piping that is buried or is within a conduit encased within a concrete floor slab (except for piping that is part of a floor heating system)	0.3	0.3	0.3
	All external flow and return piping, including 500 mm along any branch from the flow and return piping	0.3	0.6	1.0
	All internal flow and return piping, including 500 mm along any branch from the flow and return piping	0.3	0.3	0.3

NOTES:

- 1 An external location of a building is an unenclosed area and includes—
 - (a) an open sub-floor area of a building; and
 - (b) the area of a building located under an open veranda or carport, or the like.
- 2 The total R-values in Table 8.2 may be achieved for most heated water piping materials by using the following insulation:
 - (a) 13 mm of closed cell polymer, $R = 0.3$
 - (b) 25 mm of closed cell polymer, $R = 0.6$
 - (c) 38 mm of closed cell polymer, $R = 1.0$
- 3 Total R-values for insulation materials are calculated using the following:
 - (a) R-value: the thermal resistance ($\text{m}^2\cdot\text{K}/\text{W}$) of a component calculated by dividing its thickness by its thermal conductivity.
 - (b) Total R-value: the sum of the R-values of the individual component layers in a composite element including the air space and associated surface resistances.
- 4 Circulating heated water piping includes piping on solar water heating systems.

8.3 PROTECTION OF INSULATION**8.3.1 Insulation exposed to the weather**

Where insulation is exposed to the weather, it shall be of a weather-resistant type or surrounded by a weather-resistant enclosure.

8.3.2 Protection of thermal insulation on buried piping

Thermal insulation on buried piping shall be protected as follows:

- (a) All absorptive insulation material shall be effectively protected against moisture penetration by an outer cover made of a durable waterproof material.
- (b) Where insulation is cut for joining purposes, the joint shall be wrapped with a durable inert waterproof tape.

8.4 HEAT TRAPS

Heat traps are required in new and replacement installations as follows:

- (a) All storage water heaters shall have a heat trap within 1 m from the outlet of the water heater and before the first branch (see Figure 8.1).
- (b) The heat trap shall have a vertical drop of 250 mm from the outlet level of the storage water heater if the heat trap is not an integral part of the water heater.
- (c) Where a heat trap is integral with the storage water heater and this is indicated by the permanent marking on the water heater, an external heat trap is not required.

8.5 CONTAINER FOR STORAGE OF HEATED WATER

Any container used to store heated water, that is:

- (a) not a water heater; and
- (b) not required to comply with AS 3498 or AS/NZS 2712,

shall be thermally insulated to a total R-value of 1.0.

NOTE: This Clause applies to a container that is not included in the authorization of water heaters and other heated water storage tanks covered by the Minimum Energy Performance Scheme (MEPS).

8.6 R-VALUE CALCULATIONS

The total R-value of a pipe fitted with a single layer of insulation may be calculated approximately as follows:

$$R = \frac{x_i}{k_i} + \frac{x_p}{k_p}$$

where:

R = total thermal resistance ($\text{m}^2 \cdot \text{K} / \text{W}$)

x_i = thickness of insulation (m)

k_i = thermal conductivity of insulation material ($\text{W} / \text{m} \cdot \text{K}$)

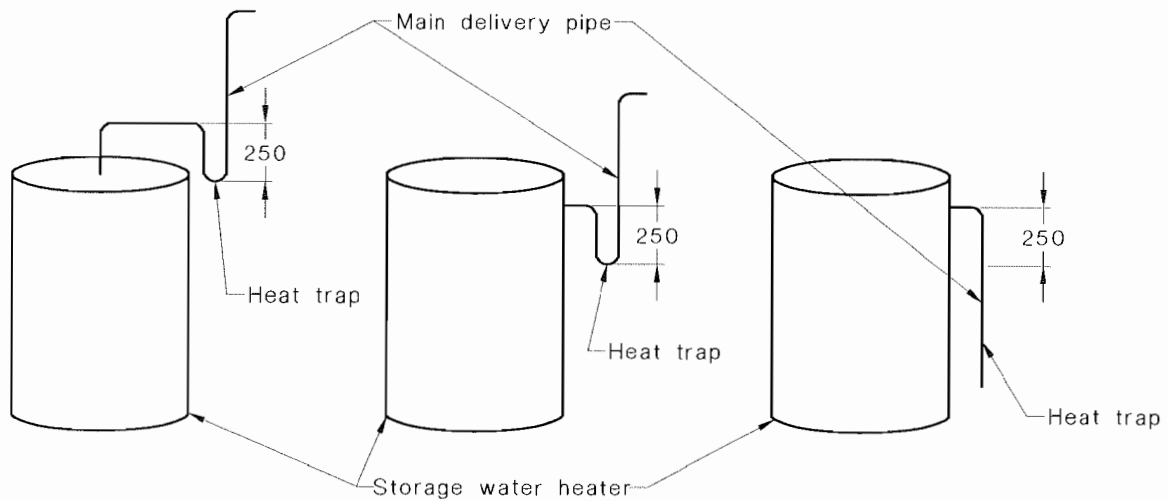
x_p = thickness of pipe wall (m)

k_p = thermal conductivity of pipe material ($\text{W} / \text{m} \cdot \text{K}$)

8.7 WATER EFFICIENCY

The maximum flow rate from an outlet for a shower, basin, kitchen sink or laundry trough shall not exceed 9L/min.

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NOTE: Heat traps are to be within 1 m from the outlet of unvented storage water heaters.

DIMENSIONS IN MILLIMETRES

FIGURE 8.1 EXTERNAL HEAT TRAPS—TYPICAL CONFIGURATIONS

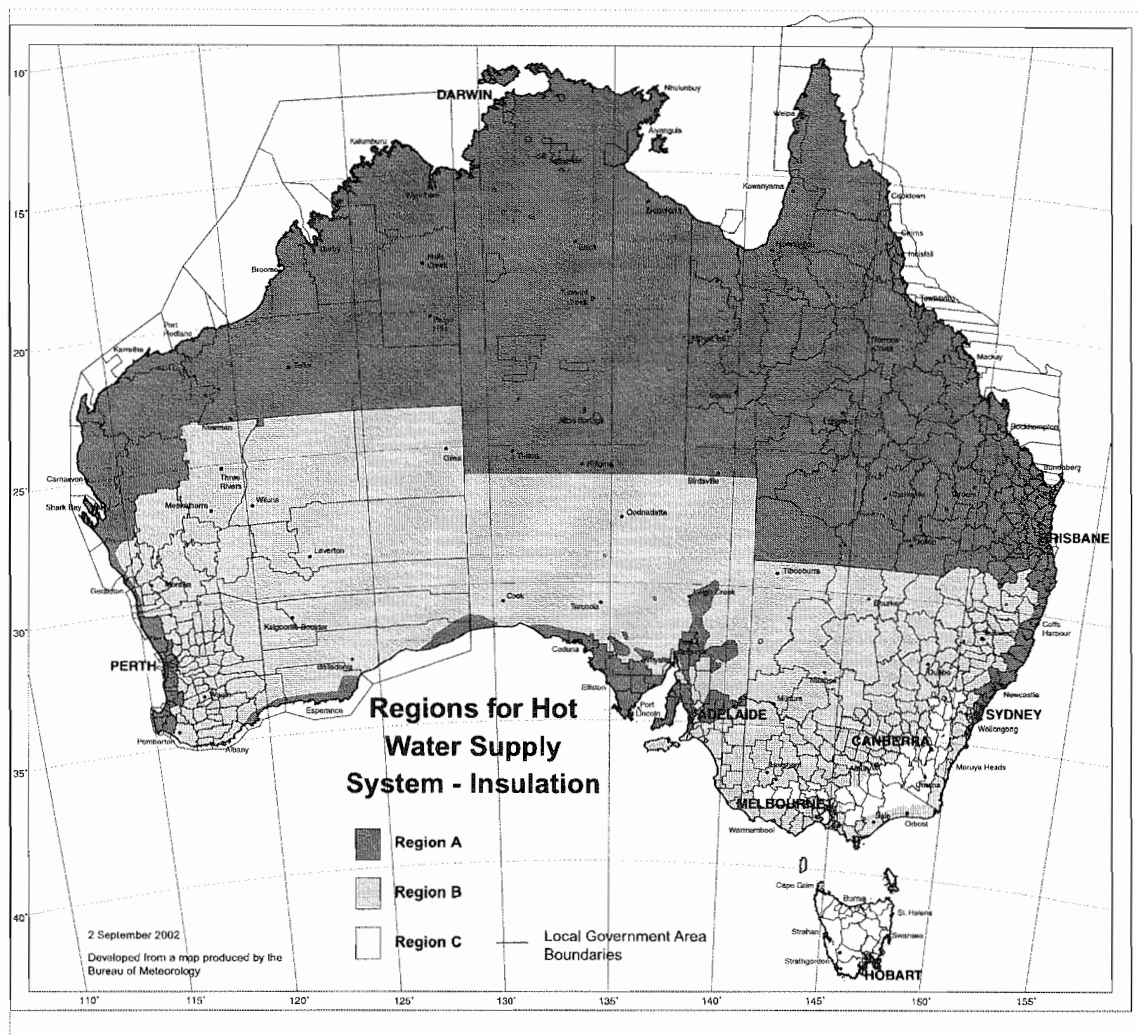


FIGURE 8.2 CLIMATE REGIONS—AUSTRALIA

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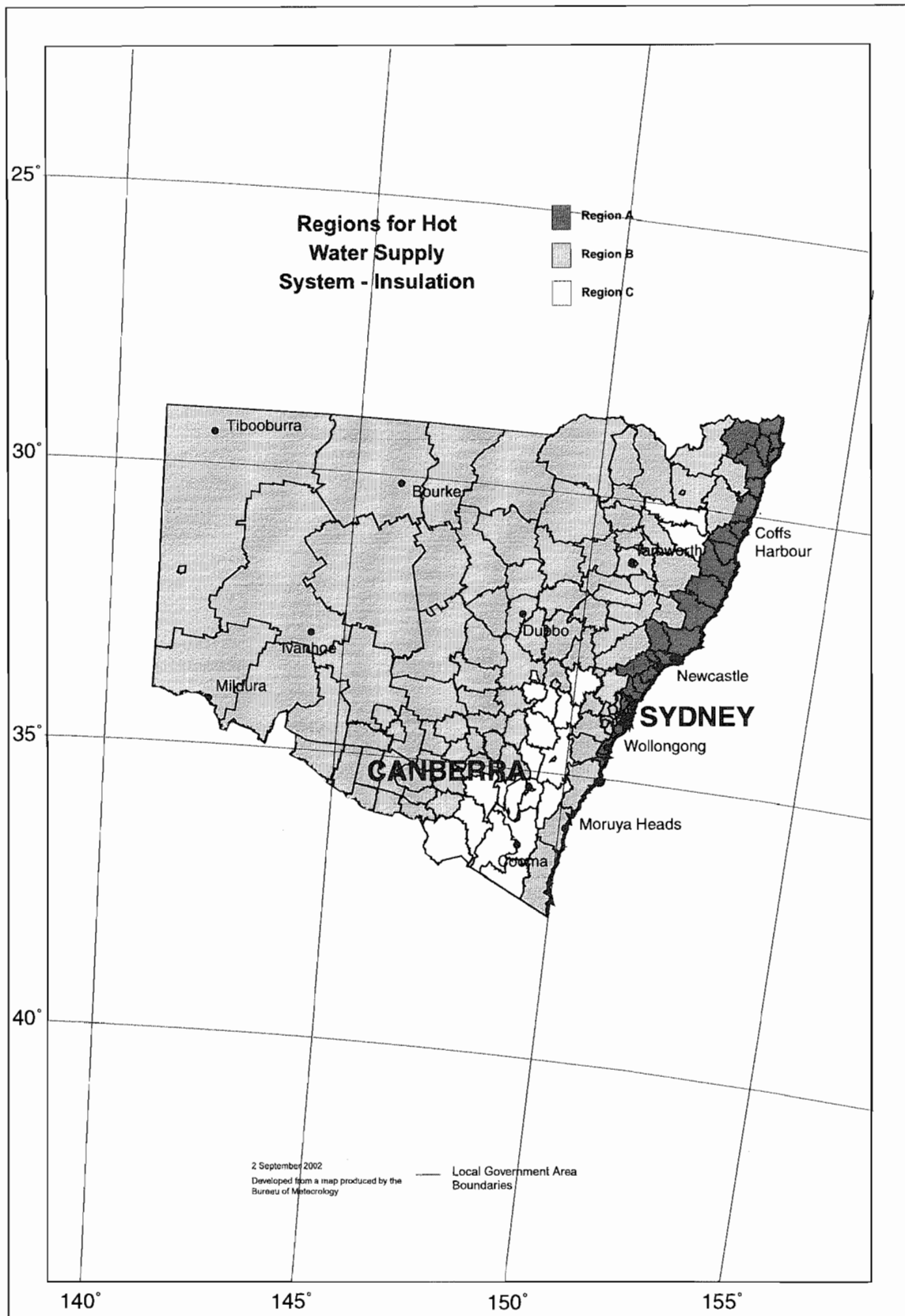


FIGURE 8.2 (A) CLIMATE REGIONS—NEW SOUTH WALES

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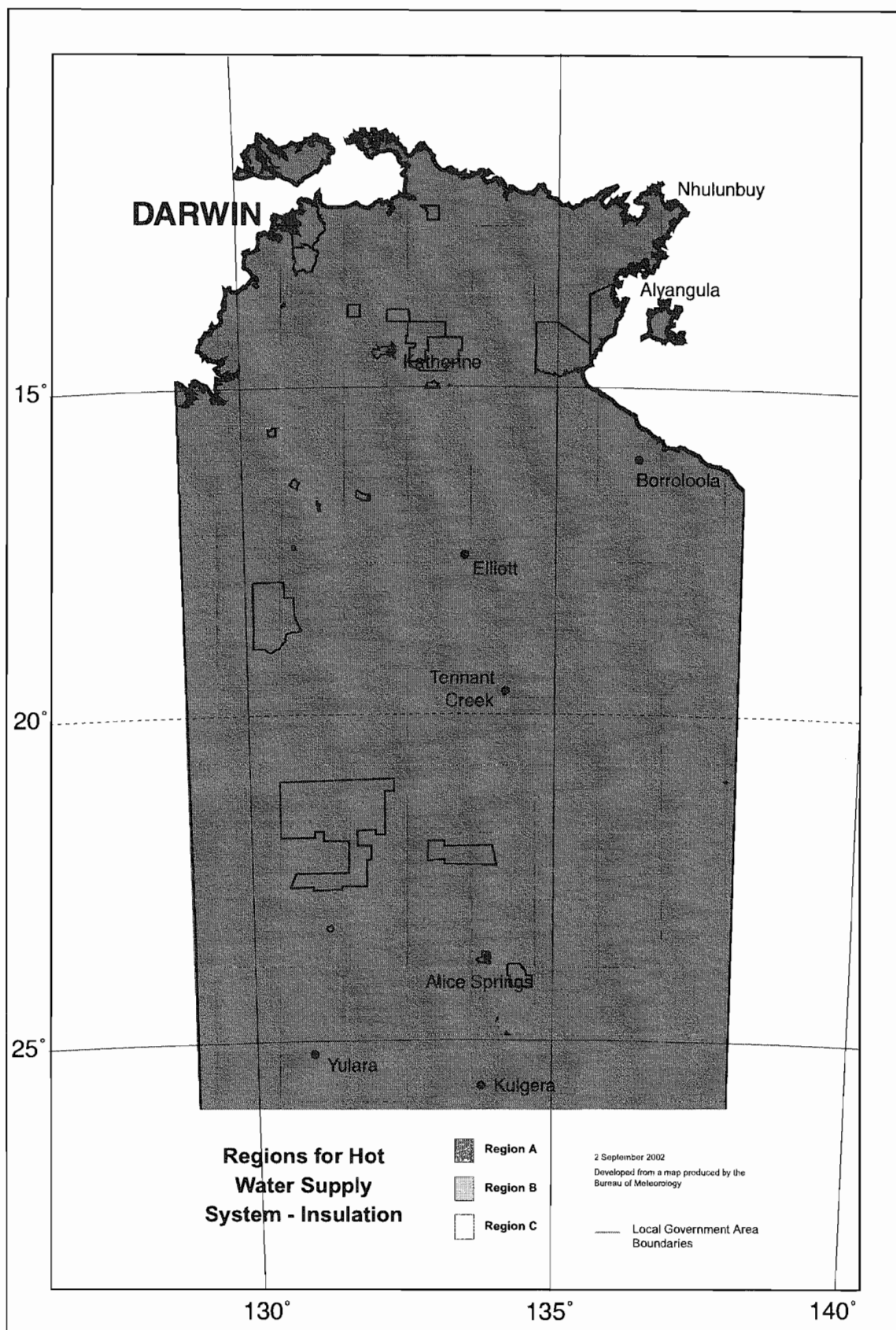


FIGURE 8.2 (B) CLIMATE REGIONS—NORTHERN TERRITORY

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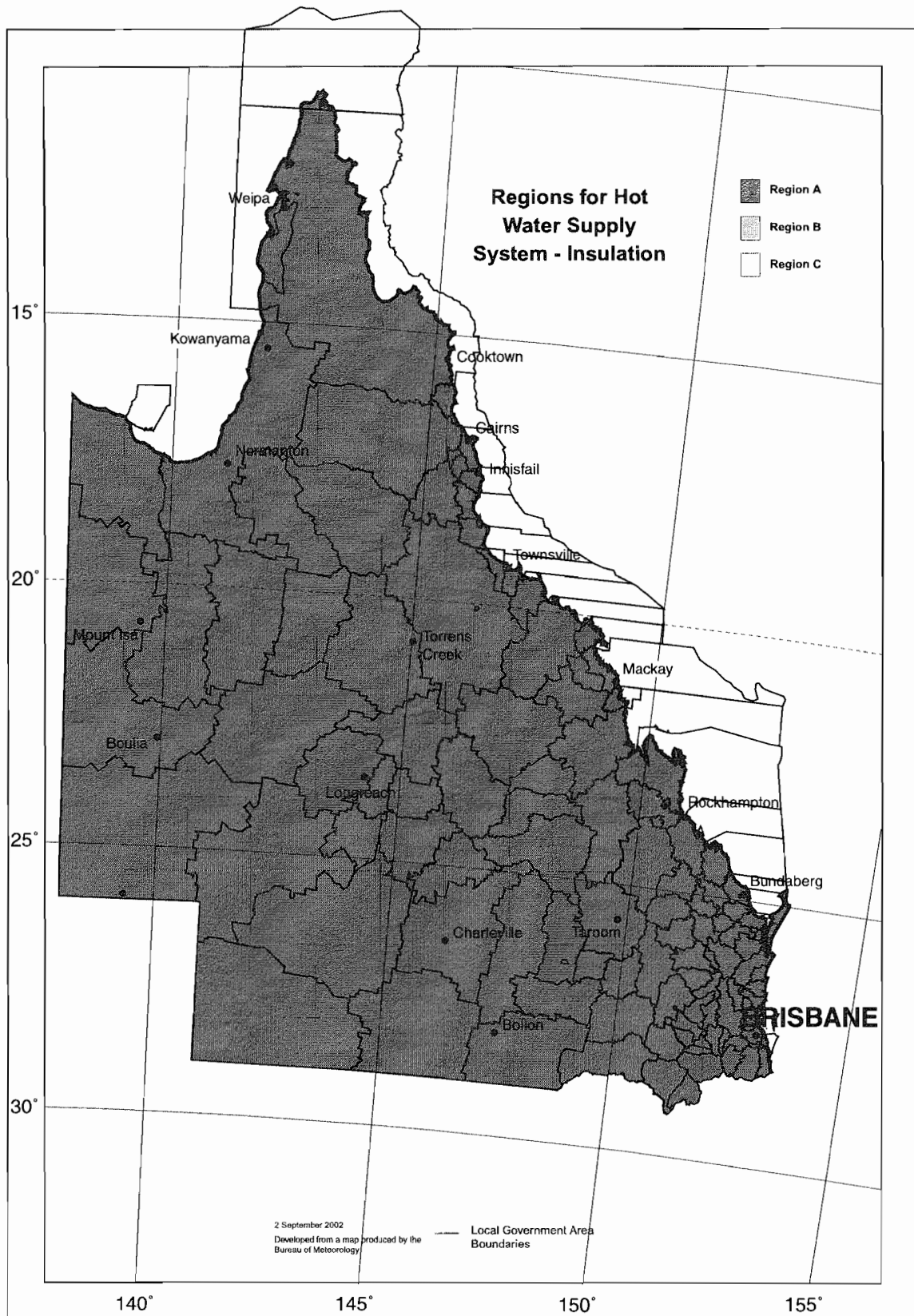


FIGURE 8.2 (C) CLIMATE REGIONS—QUEENSLAND

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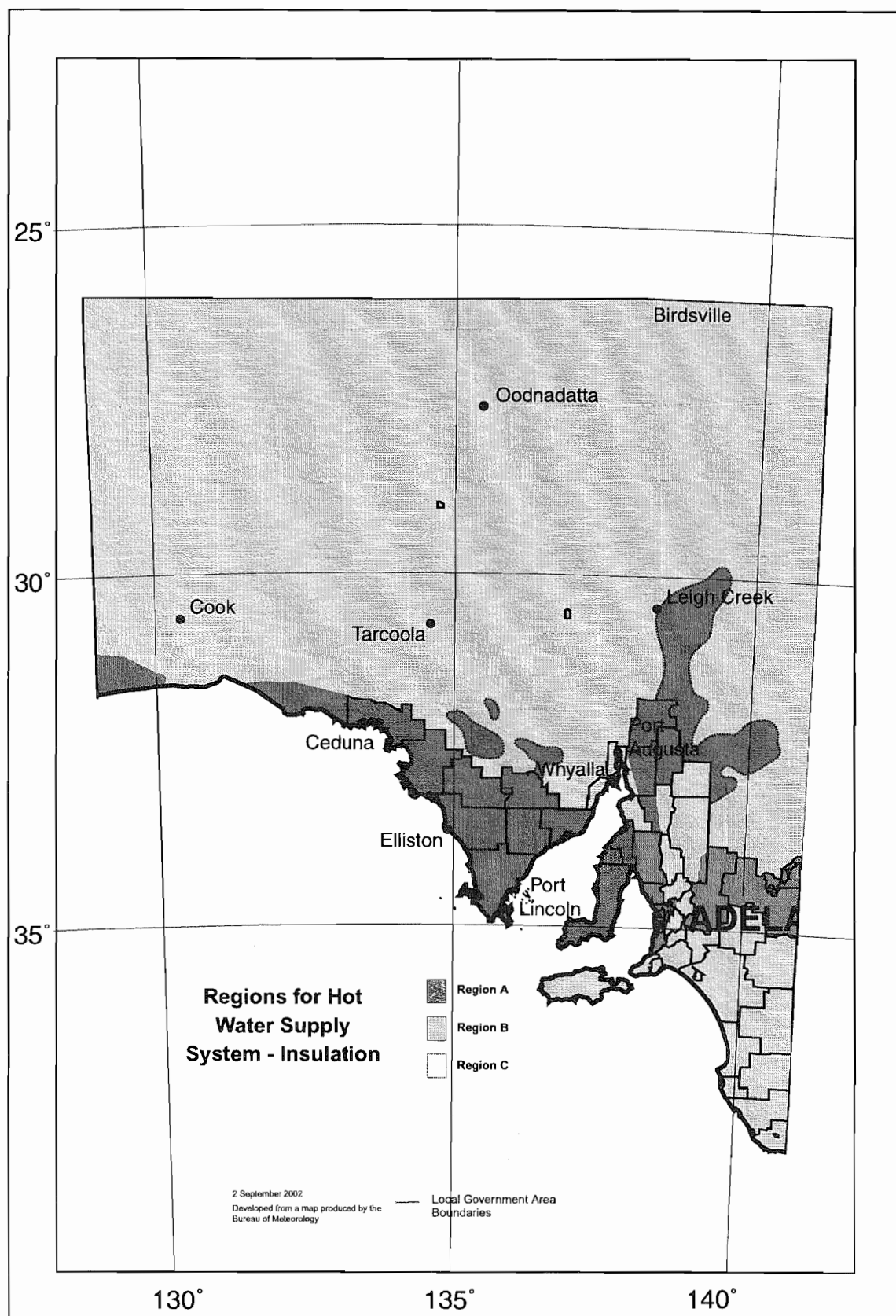


FIGURE 8.2 (D) CLIMATE REGIONS—SOUTH AUSTRALIA

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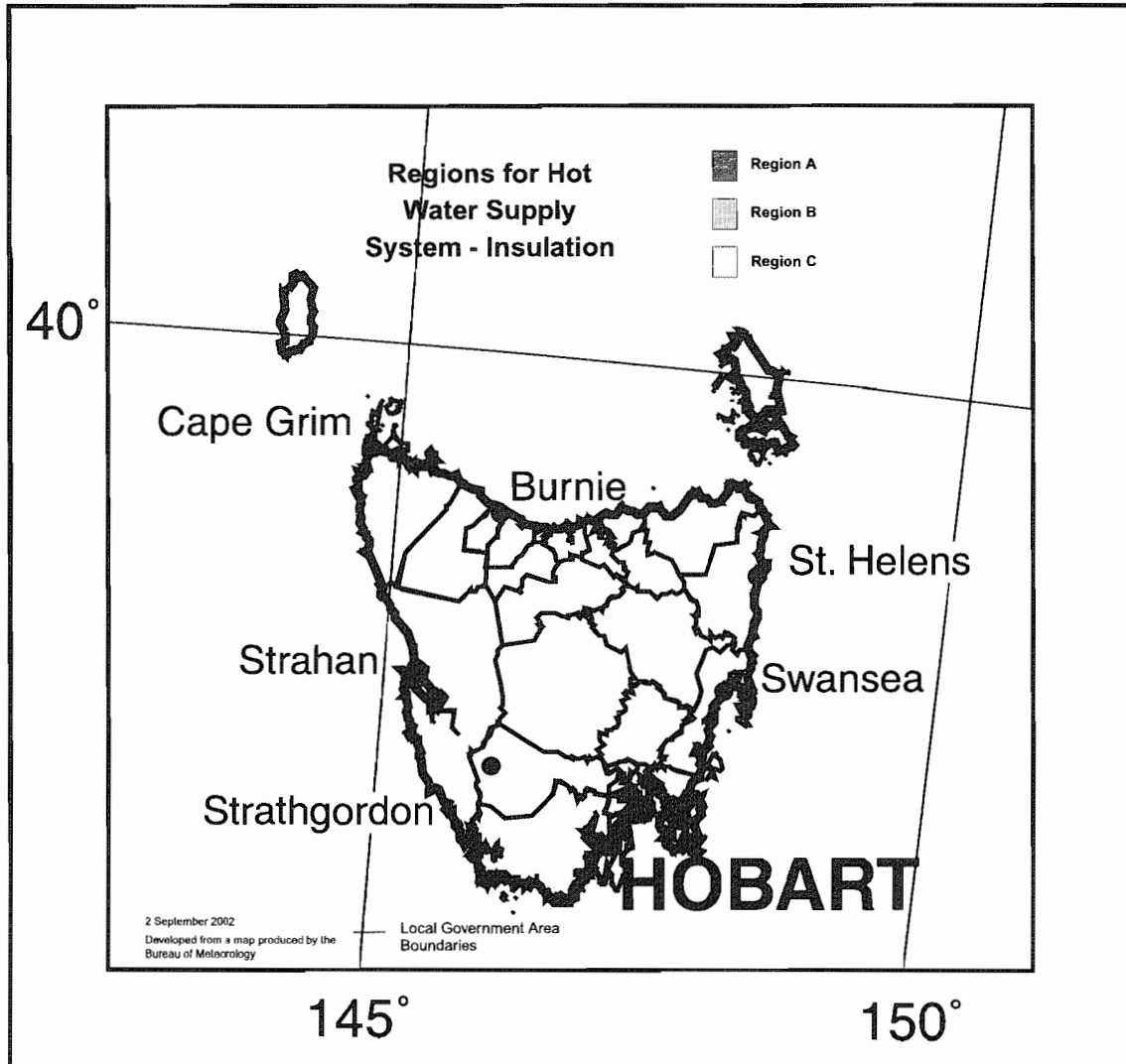


FIGURE 8.2 (E) CLIMATE REGIONS—TASMANIA

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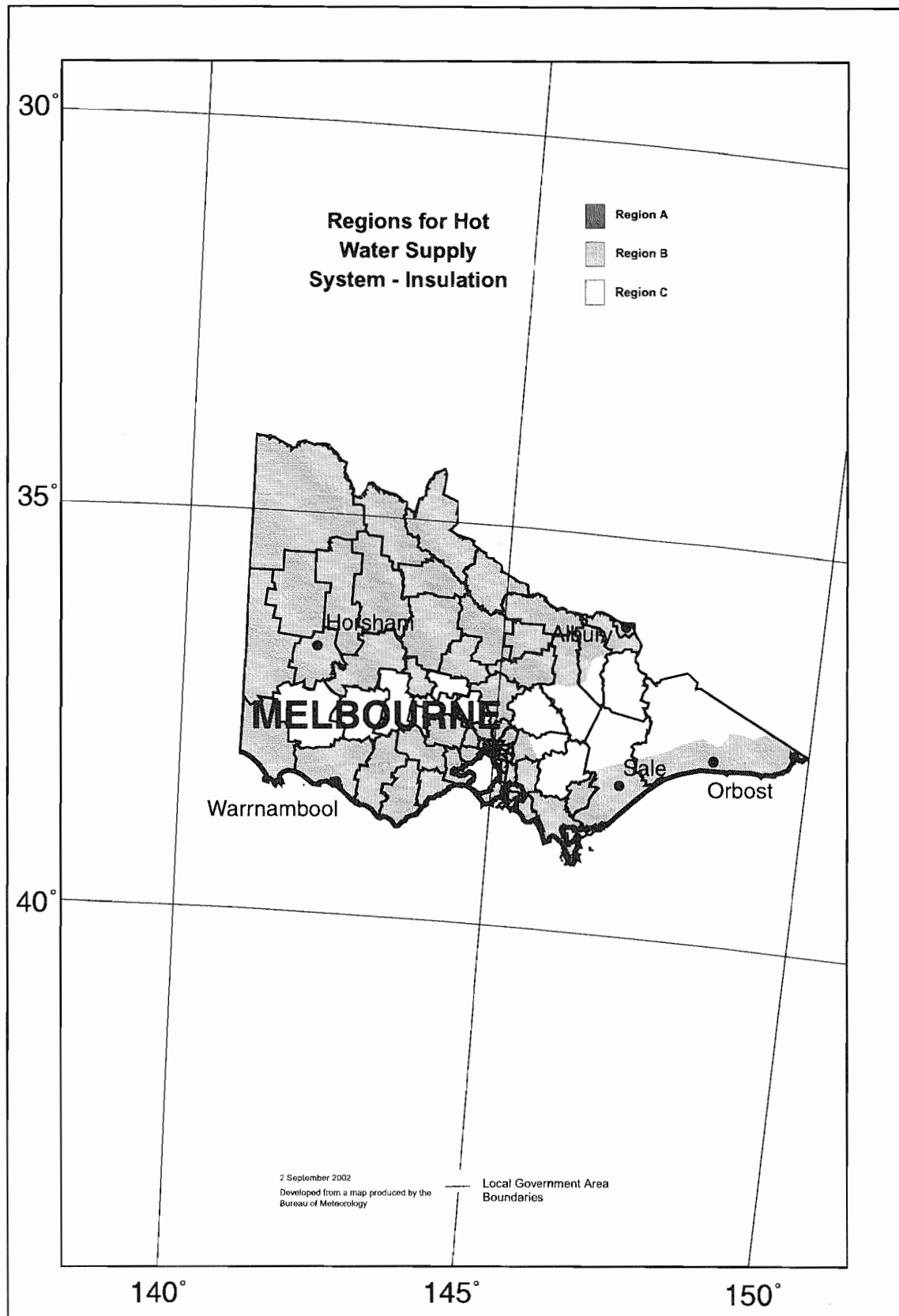


FIGURE 8.2 (F) CLIMATE REGIONS—VICTORIA

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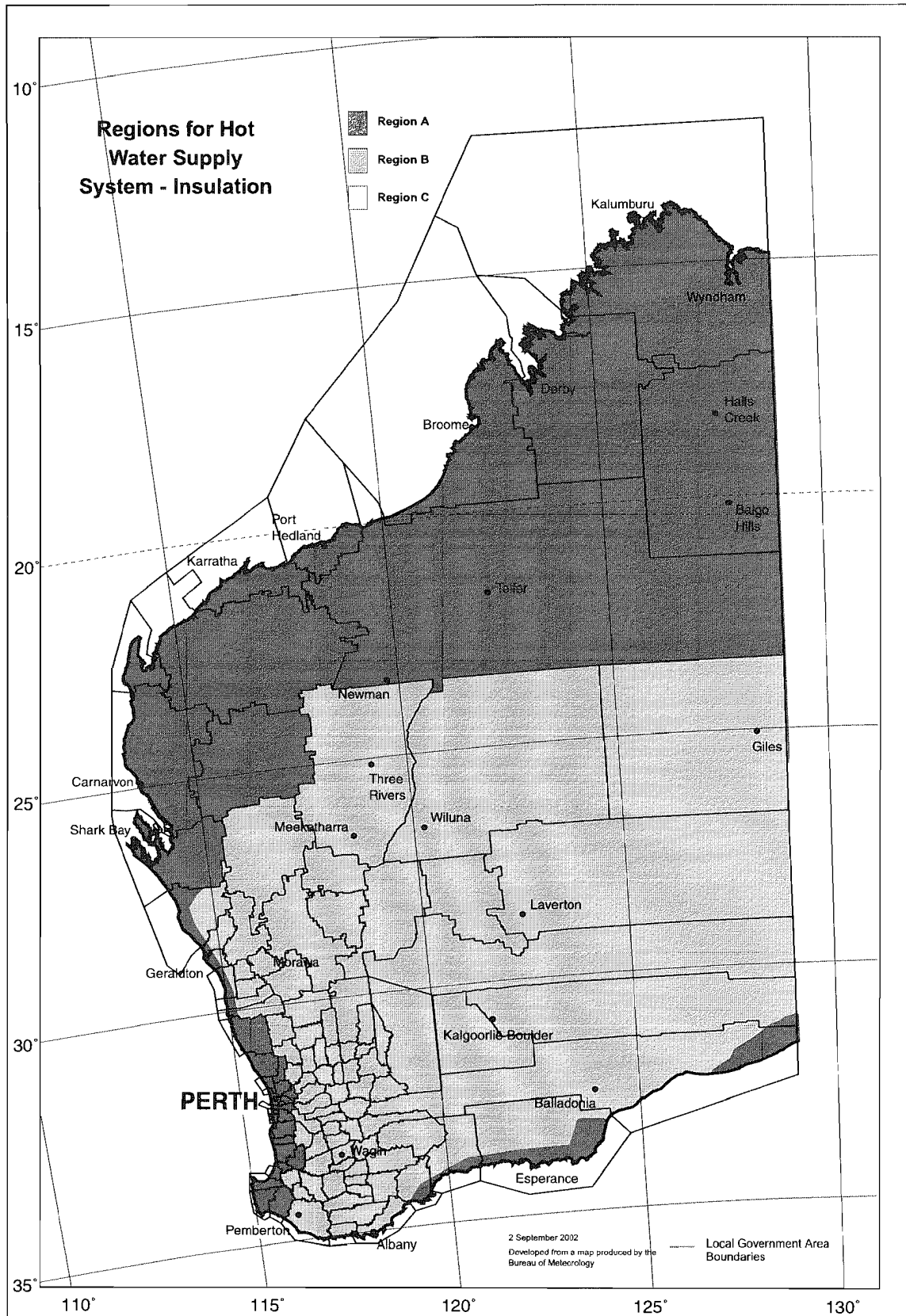


FIGURE 8.2 (G) CLIMATE REGIONS—WESTERN AUSTRALIA

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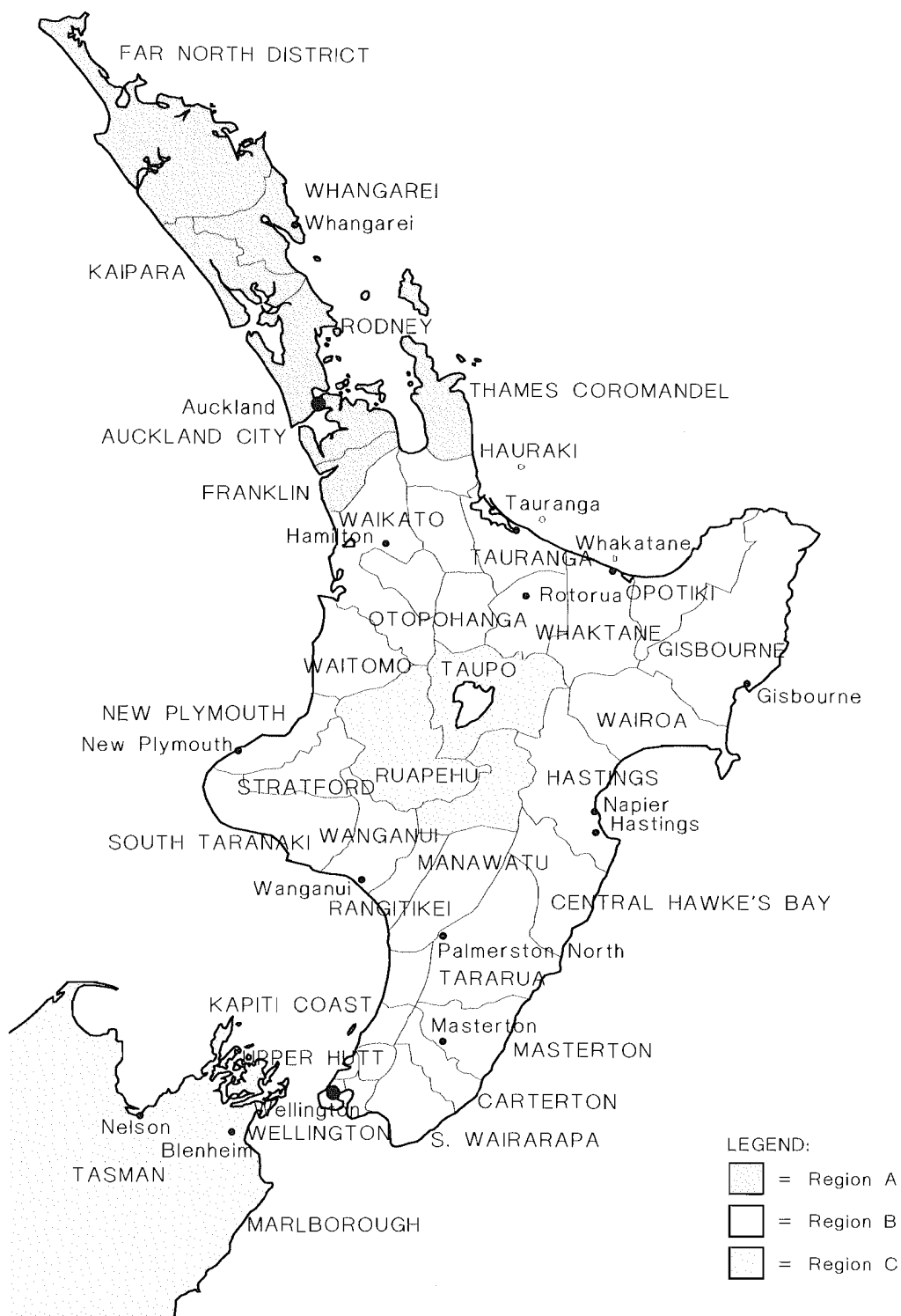


FIGURE 8.3 NEW ZEALAND CLIMATE REGIONS

SECTION 9 HEATED WATER BELOW 60 °C

This Section is being developed to set out the requirements for heated water systems that distribute and deliver heated water below 60°C and provide installation solutions and appropriate maintenance standards for the designer, installer and the maintenance plumber.

NOTES:

- 1 Section 9 has been reserved so that the work on circulating heated water systems, when completed, can be included in this Standard without extensive renumbering of clauses.
- 2 Handbook HB 263 provides guidelines for heated water systems below 60°C.
- 3 This Section will be expanded after further consultation.

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SECTION 10 HEATED WATER SERVICES FOR PEOPLE WITH DISABILITIES

10.1 SCOPE OF SECTION

This Section sets out the requirements for heated water services installed for people with disabilities (see Clause 1.9).

10.2 GENERAL

Facilities for people with disabilities need to comply with the requirements of the BCA for Australia and NZS 4121 or NZBC G1 for New Zealand

NOTE: The authority having jurisdiction may require the installation of thermostatic mixing valves on the heated water supply to fixtures intended for the use of people with disabilities.

SECTION 11 TESTING AND COMMISSIONING

11.1 SCOPE OF SECTION

This Section specifies requirements for testing and commissioning a heated water service.

NOTE: All fixtures, appliances, water tanks, storage water heaters and other equipment, which may be damaged during pressure testing, should be isolated before testing.

11.2 FLUSHING

Prior to hydrostatic testing, the piping system shall be cleaned and flushed to remove foreign matter. The flushing shall continue until the flushed water runs completely clear. See Clause 3.3 for special conditions for thermostatic mixing valves. After flushing, each line strainer shall be inspected and cleaned as necessary.

11.3 TESTING

When all draw-off points are closed, those pipes that are subjected to pressure shall be hydrostatically tested in accordance with the following:

- (a) The completed heated water reticulation, excluding the storage container or water heater, shall not leak when tested with water at ambient temperature at a pressure of 1500 kPa for a period of not less than 30 min. Prior to testing, the heating medium shall be isolated. It may be necessary to disconnect fixtures, appliances and valves in order to prevent damage during testing.
- (b) Testing shall be carried out on all piping prior to being insulated or concealed in ducts, chases or trenches.
- (c) The complete system (including valves, pumps and other equipment) shall be tested under normal working conditions for a period of not less than 48 h. The system shall be checked visually for leaks.
- (d) All safe trays and safe wastes shall be tested with water to ensure that they do not leak under full flow conditions.
- (e) All drain pipes from expansion control and temperature/pressure-relief valves and all vent pipes shall be tested with water to ensure that they are unobstructed and are open to the atmosphere.

11.4 COMMISSIONING

The heated water service shall be commissioned in accordance with the following:

- (a) The system shall be charged with water prior to the heating medium being applied to the heater.
- (b) All air shall be fully purged from the system.
- (c) The following items shall be checked for correct operation, as applicable:
 - (i) Leakage from each temperature/pressure-relief valve, pressure-relief valve and expansion control valve.
 - (ii) Stored water temperature in accordance with Clause 1.9.1 or the water heater is certified to AS 3498.
 - (iii) Hot water delivery temperature in accordance with Clause 1.9.2.
 - (iv) Water level in a gravity-type system.

- (v) Inlet isolating valve, fully open.
- (vi) Flow rate at outlet points.
- (vii) Pump.
- (viii) Flow and return temperatures.
- (ix) Inlet pressures where a reduced pressure valve is installed.
- (x) Vibration, noise or water hammer.
- (xi) Each multiple heater unit shall be checked for operation, individually.

11.5 OPERATING INSTRUCTIONS

Operating instructions shall be made available to the owner or occupier of the premises.

SECTION 12 OPERATION AND MAINTENANCE

12.1 SCOPE OF SECTION

This Section sets out the requirements for the operation and maintenance of a heated water system.

12.2 GENERAL

In order to ensure maximum performance and length of operation, water heaters shall be periodically inspected in accordance with the manufacturer's instructions.

12.3 MAINTENANCE OF HEATED WATER SERVICES

Heated water services shall be maintained in accordance with the following:

- (a) *Water treatment units* Where installed, water treatment units shall be inspected periodically to ensure proper operation.
- (b) *Water vessels and tanks* All vessels and tanks shall be inspected and cleaned periodically, and in accordance with any requirements of the regulatory authority.
NOTE: The frequency of periodic cleaning depends upon the quality of the supply water, design, materials of construction and the pipe system. Combinations of materials giving rise to corrosion should be avoided.
- (c) *Valves* The following temperature control valves shall be inspected periodically to ensure proper operation.
 - (i) Temperature/pressure-relief valves.
 - (ii) Expansion-control valves.
 - (iii) Thermostatic mixing valves.
 - (iv) Tempering valves.
 - (v) Other associated valves/devices.
- (d) The requirements of AS/NZS 3666.2, where applicable.

APPENDIX A

NORMATIVE REFERENCES

(Normative)

AS	
1074	Steel tubes and tubulars for ordinary service
1167	Welding and brazing—Filler metals
1167.1	Part 1: Filler metal for brazing and braze welding
1345	Identification of the contents of pipes, conduits and ducts
1357	Water supply—Valves for use with unvented water heaters (all parts)
1379	Specification and supply of concrete
1397	Steel sheet and strip—Hot-dipped zinc-coated or aluminium/zinc-coated
1432	Copper tubes for plumbing, gasfitting and drainage applications
1478	Chemical admixtures for concrete
1478.1	Part 1: Admixtures for concrete
1528	Tubes (stainless steel) and tube fittings for the food industry.
1528.1	Part 1: Tubes
1604	Specifications for preservative treatment (all parts)
1646	Elastomeric seals for water works purposes (all parts)
1722	Pipe threads of Whitworth form
1722.1	Part 1: Sealing pipe threads
1910	Water supply—Float control valves for use in hot and cold water
2129	Flanges for pipes, valves and fittings
2239	Galvanic (sacrificial) anodes for cathodic protection
2492	Cross-linked polyethylene (PE-X) pipe for hot and cold water applications
2537	Mechanical jointing fittings for use with cross-linked polyethylene (PE-X) fittings for hot and cold water applications
2813	Solar water heaters—Methods of test for thermal performance—Simulator method
2984	Solar water heaters—Methods of test for thermal performance—Outdoor test method
3498	Authorization requirements for plumbing products—Water heaters and hot-water storage tanks
3518	Acrylonitrile butadiene styrene (ABS) pipes and fittings for pressure applications
3518.1	Part 1: Pipes
3600	Concrete structures
3688	Water supply—Copper and copper alloy body compression and capillary fittings and threaded-end connectors

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AS	
3795	Copper alloy tubes for plumbing and drainage applications
4032	Water supply—Valves for the control of hot water supply temperatures
4032.1	Part 1: Thermostatic mixing valves—Materials design and performance requirements
4032.2	Part 2: Tempering valves and end of line temperature actuated devices
4087	Metallic flanges for waterworks purposes
4176	Polyethylene/aluminium and cross-linked polyethylene/aluminium macro-composite pipe systems for pressure applications
4809	Copper pipe and fittings—Installation and commissioning
AS/NZS	
1167	Welding and brazing—Filler metals
1167.2	Part 2: Filler metal for welding
1260	PVC-U pipes and fittings for drain, waste and vent applications
2280	Ductile iron pressure fittings
2544	Grey iron pressure fittings
2642	Polybutylene pipe systems
2642.2	Part 2: Polybutylene (PB) pipe for hot and cold water applications
2642.3	Part 3: Mechanical jointing fitting for use with polybutylene (PB) pipes for hot and cold water application
2712	Solar and heat pump water heaters—Design and construction
2878	Timbers—Classification into strength groups
3500	Plumbing and Drainage
3500.0	Part 0: Glossary of terms
3500.1	Part 1: Water services
3666	Air-handling and water systems of buildings—Microbial control
3666.2	Operation and maintenance
4020	Testing of products for use in contact with drinking water
4129	Fittings for polyethylene (PE) pipes for pressure applications
4234	Solar water heaters—Domestic and heat pump—Calculation of energy consumption
4331	Metallic flanges (All parts)
4671	Steel reinforcing materials
NZS	
3109	Concrete construction
3124	Specification for concrete construction for minor works
3501	Specification of copper tubes for water, gas and sanitation
3631	New Zealand timber grading rules
3640	Specification of the minimum requirements of the NZ Timber Preservation Council Inc.
4121	Design for access and mobility: Buildings and associated facilities
4602	Low pressure copper thermal storage electric water heaters

A2

NZS	
4603	Installation of low pressure thermal storage electric water heaters with copper cylinders (open-vented systems)
4607	Installation of thermal storage electric water heaters: valve-vented systems
4608	Control valves for hot water systems
4613	Domestic solar water heaters
4614	Installation of domestic solar water heating systems
5807	Code of practice for industrial identification by colour, wording or other coding
NZS/BS	
21	Pipe threads for tubes and fittings where pressure-tight joints are made on the threads
3601	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure applications
ASTM	
D2846	Chlorinated polyvinyl chloride plastic hot and cold water distribution systems
A268/ A268M	Standard specification for seamless and welded ferritic and martensitic stainless steel tubing for general service
DIN	
8077	Polypropylene (PP) pipes: dimensions
PCA	Plumbing Code of Australia
BCA	Building Code of Australia
NZBC	New Zealand Building Code (G1, Personal hygiene; G12, Water supplies)

APPENDIX B
WATER ANALYSIS
(Normative)

B1 WATER ANALYSIS

Water analysis shall be performed by an accredited analytical laboratory.

B2 TOTAL DISSOLVED SOLIDS (TDS)

The concentration of the total dissolved solids affects the conductivity and therefore influences the selection of anodes (see Clause 5.2.2).

Anode selection shall be made in accordance with the manufacturer's recommendation or, in the absence of such a recommendation, Table B1.

**TABLE B1
ANODE SELECTION**

Anode material*		
TDS, mg/L		
0–50	50–400	>400
M1	M2	A5

* See AS 2239.

B3 SCALING PROPERTIES

When heated, some waters may produce excessive scaling due to the deposition of calcium carbonate. This type of scaling can eventually lead to the blockage of valves, pipes and especially tubes in solar collectors.

B4 WATER pH

Water heaters should not be exposed to water with a pH less than 6.5 or greater than 8.5.

APPENDIX C
PIPES AND FITTINGS DEEMED TO COMPLY

(Normative)

The pipes and fittings that are deemed to be solutions, subject to the limitations Clause 2.4, include but are not limited to the following:

- (a) Copper pipes and fittings in accordance with AS 1432 (Type A, B and C only) or NZS 3501 (water pipes).
- (b) Copper alloy pipes in accordance with AS 3795.
- (c) Copper and copper alloy fittings in accordance with AS 3688.
- (d) Polybutylene (PB) pipes and fittings in accordance with AS/NZS 2642.2 and AS/NZS 2642.3.
- (e) Cross-linked polyethylene (PE-X) pipes and fittings in accordance with AS 2492 and AS 2537.
- (f) Random polymer polypropylene (PP-R) pipes and fittings in accordance with DIN 8077.
- (g) Macro-composite (PE-X-Al-PE-X) or (PE-Al-PE) pipes and fittings in accordance with AS 4176.
- (h) Chlorinated polyvinyl chloride (PVC-C) fittings in accordance with ASTM D2846.
- (i) Stainless steel (SS) pipes and fittings in accordance with AS 1528.1.

APPENDIX D

TYPICAL RATES OF FLOW

(Informative)

Typical flow rates of hot water demand at the outlet of fixtures are as follows:

- (a) Bath 0.3 L/s.
- (b) Shower..... 0.1 L/s.
- (c) Handbasin 0.1 L/s.
- (d) Kitchen sink 0.2 L/s.
- (e) Washing machine 0.2 L/s.
- (f) Laundry trough..... 0.2 L/s.

These values are for calculation purposes and are not necessarily the minimum that may be supplied (see AS/NZS 3500.1).

APPENDIX E

PREFERRED SIZES OF PIPE FOR NON-CIRCULATORY TYPICAL
SINGLE-STOREY HOUSEHOLD INSTALLATIONS

(Informative)

Feed	Minimum internal diameters of pipe mm			
	Heater operating head, kPa			
	Less than 85	85 to 170	In excess of 170	
			Storage	Instantaneous
From heater to first branch	15.0	12.5	12.5	15.0
A branch to kitchen sink or washbasin	10.0	10.0	10.0	10.0
A branch to kitchen sink and laundry	10.0	10.0	10.0	10.0
A branch to bathroom and one other room	15.0	12.5	10.0	10.0
A branch to bathroom only, all pipe in bathroom	12.5	10.0	10.0	10.0

NOTE: The above are recommended sizes only. Individual installations may require larger piping to give the flow rates detailed in Appendix D.

APPENDIX F

RECOMMENDATIONS FOR THE INSTALLATION OF UNRATED SOLAR HOT WATER SUPPLY SYSTEMS

(Informative)

F1 GENERAL

A2

A custom-built system, which may comprise components that are manufactured by different manufacturers and are not specifically designed for use with each other, may not perform in a predictable manner nor be rated. Such systems commonly result from the addition of a new component to an existing component, e.g. solar collectors added to an existing hot water system. However, it is possible to avoid fundamental design mistakes in such systems, and the recommendations set out in this Appendix embody what is considered good practice in order to obtain a reasonable solar contribution.

F2 VOLUMETRIC STORAGE CAPACITY

The volumetric storage capacity of the container should be not less than the anticipated average daily consumption of the household.

For increased solar performance, a volumetric storage capacity of 1.5 to 2.0 times the anticipated average daily consumption of the household is recommended (see also Appendix H).

For systems using off-peak supplementary electric heating, the volumetric storage capacity of the container should be not less than 1.5 times the anticipated average daily consumption of the household.

F3 RECOMMENDED OPERATING TEMPERATURE

The solar hot water system shall incorporate supplementary heating. For the purpose of obtaining an acceptable solar contribution, such supplementary heating (whether integral or remote) should be suitable for operation at 60°C nominal temperature.

F4 TEMPERATURE/PRESSURE-RELIEF VALVE

The temperature/pressure-relief-valve should be sized to allow for the energy input of the collectors at 99°C.

F5 COLLECTOR/CONTAINER SIZE RATIO

F5.1 Normal conditions

The collector aperture should be related to the volume of the container and to the location of the installation as indicated in Table H1, Appendix H.

NOTE: Slightly less collector aperture will be required for collectors with selective surfaces. Care has to be taken to prevent excessive hot water temperatures with selective surface collectors.

Reference should also be made to Clauses 6.4.4.1 and 6.4.4.5.

F5.2 Non-optimum conditions

Where the operation of the collector is adversely affected by shade, inclination, orientation, excessive dust, smog, cloud, or the like, the size of the collector should be increased to compensate.

A2

F6 COMPONENTS

Where a system is made up of components that have not been tested as a packaged system in accordance with AS/NZS 2712, the individual components should comply with AS/NZS 2712.

F7 CLAIMED PERFORMANCE

Claimed performance of a custom-built system may be related to a tested packaged system where the components have been individually tested and the ratio of collector aperture area to volume of the container are similar.

APPENDIX G

RECOMMENDATIONS FOR THE INSTALLATION OF CLOSE-COUPLED AND INTEGRAL SOLAR HOT WATER SYSTEMS ON ROOFS

(Informative)

G1 GENERAL

The installation of a close-coupled or integral solar hot water system, which includes a container as well as collectors, on the roof of a building will impose additional loading on the roof structure. Care should be taken to ensure that the roof and building structure are capable of accepting this additional load. The recommendations set out in this Appendix are intended as a basic guide to a practice that has been found satisfactory in non-cyclonic areas.

G2 SUPPORT

G2.1 'With pitch' installations

Solar hot water systems mounted directly onto a roof structure, i.e., 'with pitch' installations (see Figure G1), should be arranged so that their weight is distributed evenly over as many roof rafters as possible. Roof struts supporting underpurlins that are affected by the additional load should be directly supported from load-bearing walls or adequately designed strutting beams.

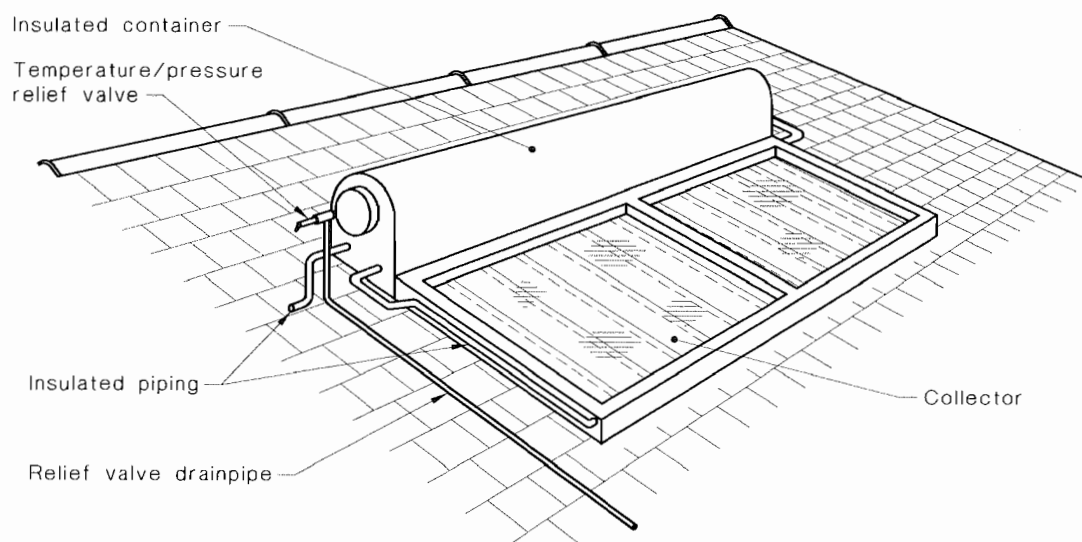


FIGURE G1 'WITH PITCH' INSTALLATION

G2.2 'Against pitch' installations

Solar hot water systems mounted on frames above roof structures at angles opposed to the roof pitch, i.e. 'against pitch' installations (see Figure G2), and which cause point loads, should have the container point loads taken through the roof membrane and be directly supported from load-bearing walls or adequately designed strutting beams.

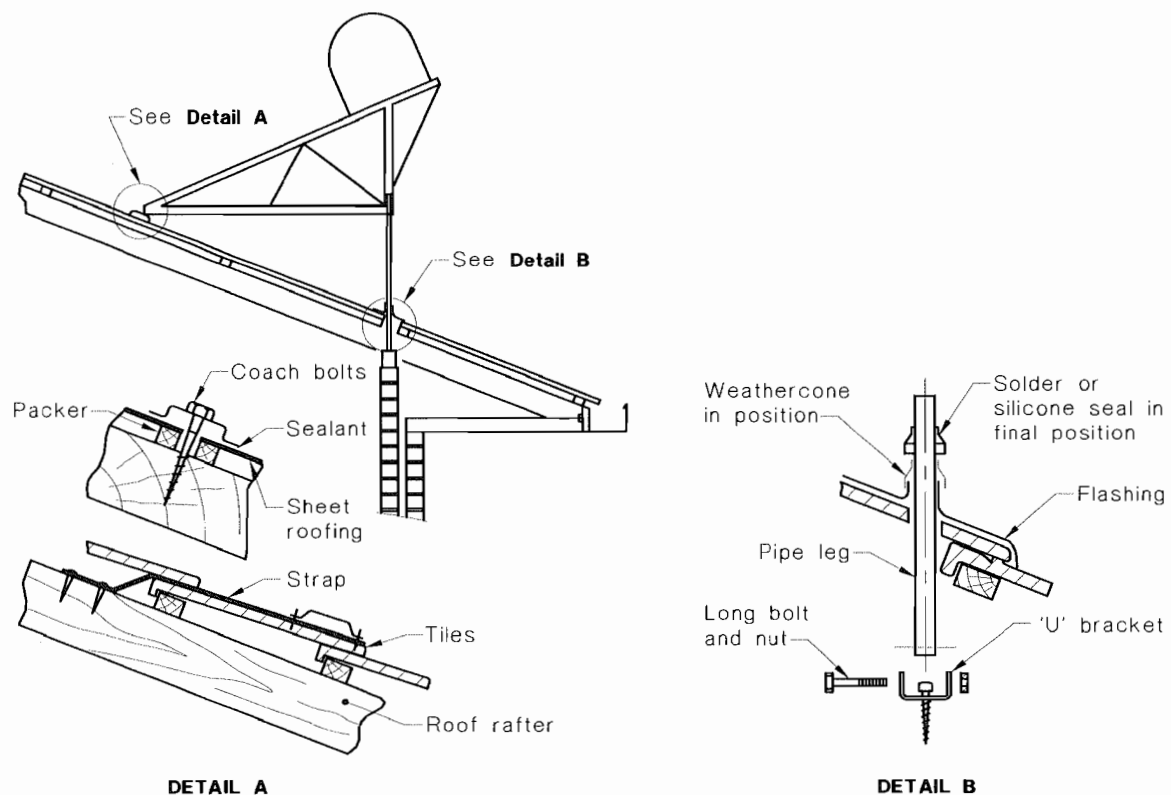


FIGURE G2 'AGAINST PITCH' INSTALLATION

G2.3 'Cross-pitch' installations

Solar hot water systems mounted on frames above roofs across the pitch of the roof, i.e., 'cross-pitch' installations (see Figure G3), and which cause point loads, should be arranged so that one side of the system is directly supported from a load-bearing wall; the other side of the system should be directly supported from a strutting beam taking the load to not less than two timber studs at each end of the beam.

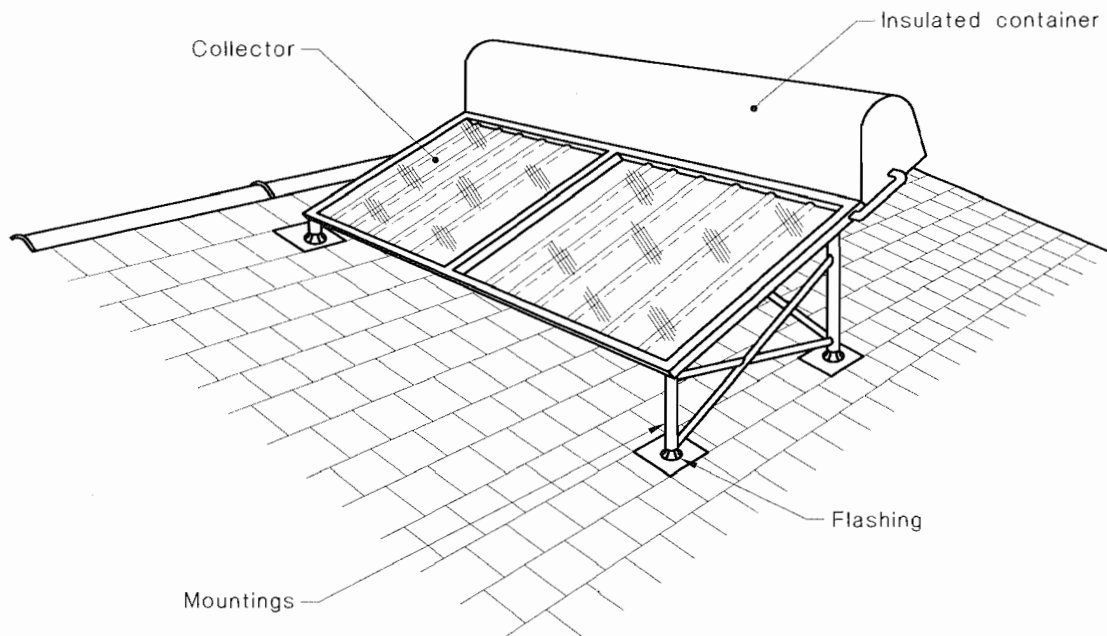


FIGURE G3 CROSS-PITCH INSTALLATION

G3 POINTS TO NOTE

When installing close-coupled and solar water heaters, it is necessary to observe the following precautions:

- (a) The internal structure of the existing roof and the soundness of the roof timbers should be checked. Based on these observations or the recommendations of an engineer's report, additional strengthening may be required.
- (b) Containers should not be placed in the middle of the roof over a large room.
- (c) Where possible, the container should be located towards the apex of the roof and over bathroom or laundry areas, where the internal roof structures are usually adequately supported from internal walls.
- (d) Particular attention should be paid to installations on sheet-clad roofs. The generally wider timber spacings may require each rafter affected by the additional load to be strengthened or provided with additional support.
- (e) On roofs where it is not possible to make an internal inspection, or where inspection reveals marginal agreement with the recommendations of this Standard, a further check should be made with the building authority prior to proceeding with the installation.
- (f) Where a secondary metallic tile roofing has been installed over the initial roof cladding, any fixings which can be made to the roof members, should be made to the original roof structure and not to any secondary roofing members.

APPENDIX H

A2

SOLAR HOT WATER SYSTEMS—SUGGESTED COMPONENT SIZES
(CUSTOM-BUILT SYSTEMS)

(Informative)

H1 GENERAL

The data presented in this Appendix should be read in conjunction with the text of the Standard.

H2 ANTICIPATED SOLAR FRACTION

The anticipated solar fraction (f) listed in Table H1 is for typical solar hot water systems installed in houses and incorporating a well-designed flat plate collector with a well-insulated container having a draw-off capacity not less than 80% container storage volume. However, the values for storage container capacity and collector area do not necessarily relate to any particular commercially available close-coupled systems. All data presented in this Appendix correspond to the average requirements of a four-person household.

TABLE H1
SUGGESTED COMPONENT SIZES
(CUSTOM-BUILT SYSTEMS)

1	2	3	4	5
Location	Collector		Container storage	Anticipated solar fraction (f)
	Angle of inclination	Area		
	Degrees	m ²		
Adelaide	35 (35)	4	315	74
Alice Springs	32 (24)	4	315	94
Auckland	35 (37)	4	360	65
Brisbane	29 (27)	4	315	81
Christchurch	35 (43.5)	4	360	60
Canberra	33 (35)	4	315	67
Darwin	15 (12)	3	270	97
Hobart	42 (43)	5	360	65
Invercargill	20 (40)	4	360	56
Melbourne	38 (38)	5	360	67
Perth	33 (32)	4	315	77
Sydney	34 (34)	4	315	76
Wellington	35 (41)	4	360	60

NOTES:

- Column 2: Nominal angle of inclination of flat plate collector to horizontal (see Clause 6.5.1.4). Latitude angle is shown in parentheses.
- Column 3: Collector aperture area expressed in square metres. This area is for optimum conditions of collector inclination and orientation. For non-optimum conditions, the solar fraction will be reduced (see Appendix J) and a greater area may be required.
- Column 5: Anticipated average annual solar energy fraction (f) expressed as a percentage of total hot water energy delivered, i.e.—

$$f = \frac{E_{wh} - E_p}{E_{wh}} \times 100$$

where

E_{wh} = hot water energy delivered at water heater outlet
(mass × specific heat capacity × temperature differential)

E_p = total supplementary energy purchased for water heating

- The actual solar fraction will vary with household hot water use patterns and with weather variations from year to year. The figures given should be accurate to within 5% for normal situations.

H3 SOLAR RADIATION DATA

Basic solar radiation data is given in Figures H1 and H2 for Australia and Figure H3 for New Zealand. For more comprehensive details of solar radiation, reference should be made in Australia to the *Australian Solar Radiation Data Handbook*, published by the Department of Resources and Energy, Canberra, and, in New Zealand, to the National Institute of Water and Atmospheric Research Ltd., Wellington.

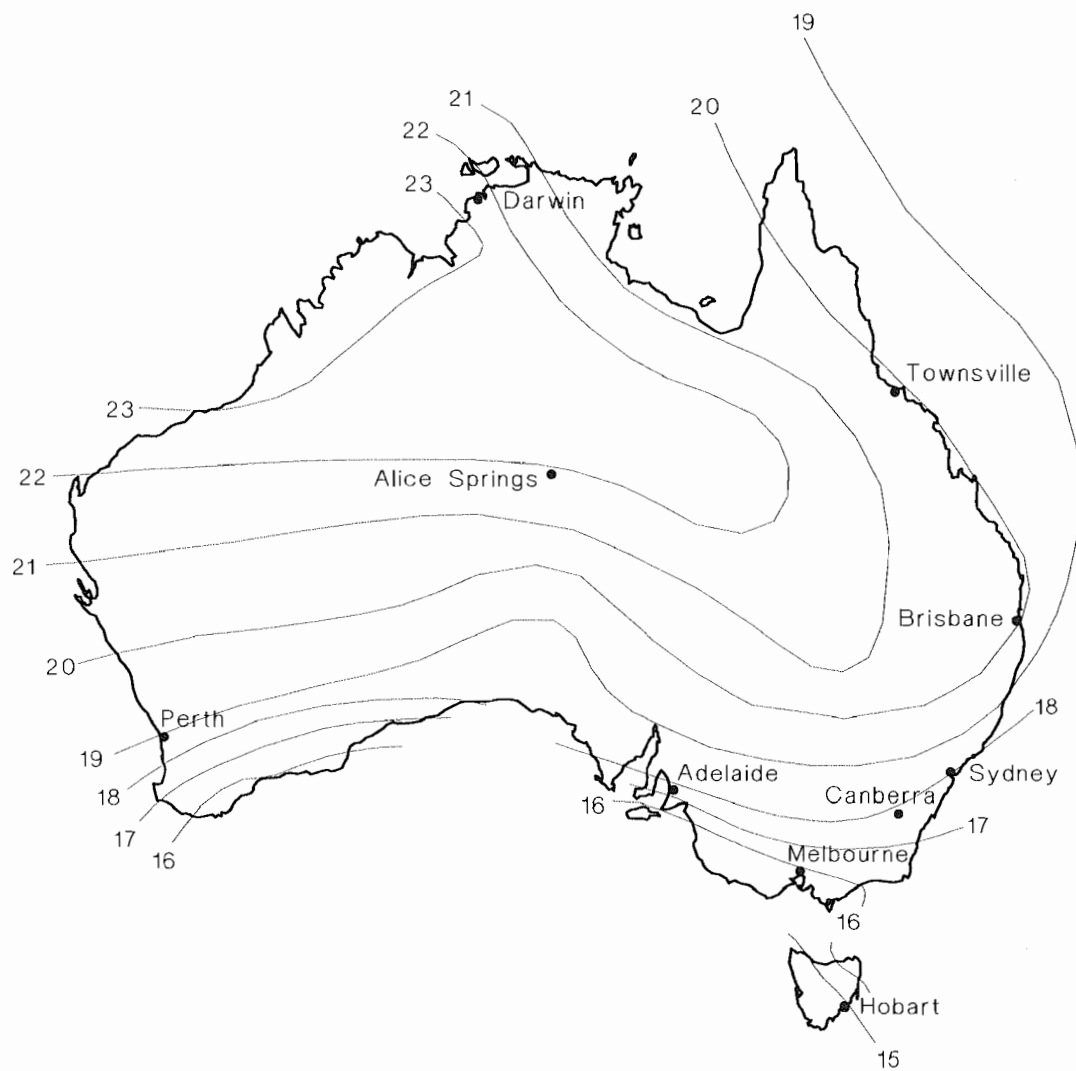


FIGURE H1 CONTOURS OF ANNUAL MEAN DAILY SOLAR RADIATION ON A HORIZONTAL SURFACE (MJ/m².d)



A2

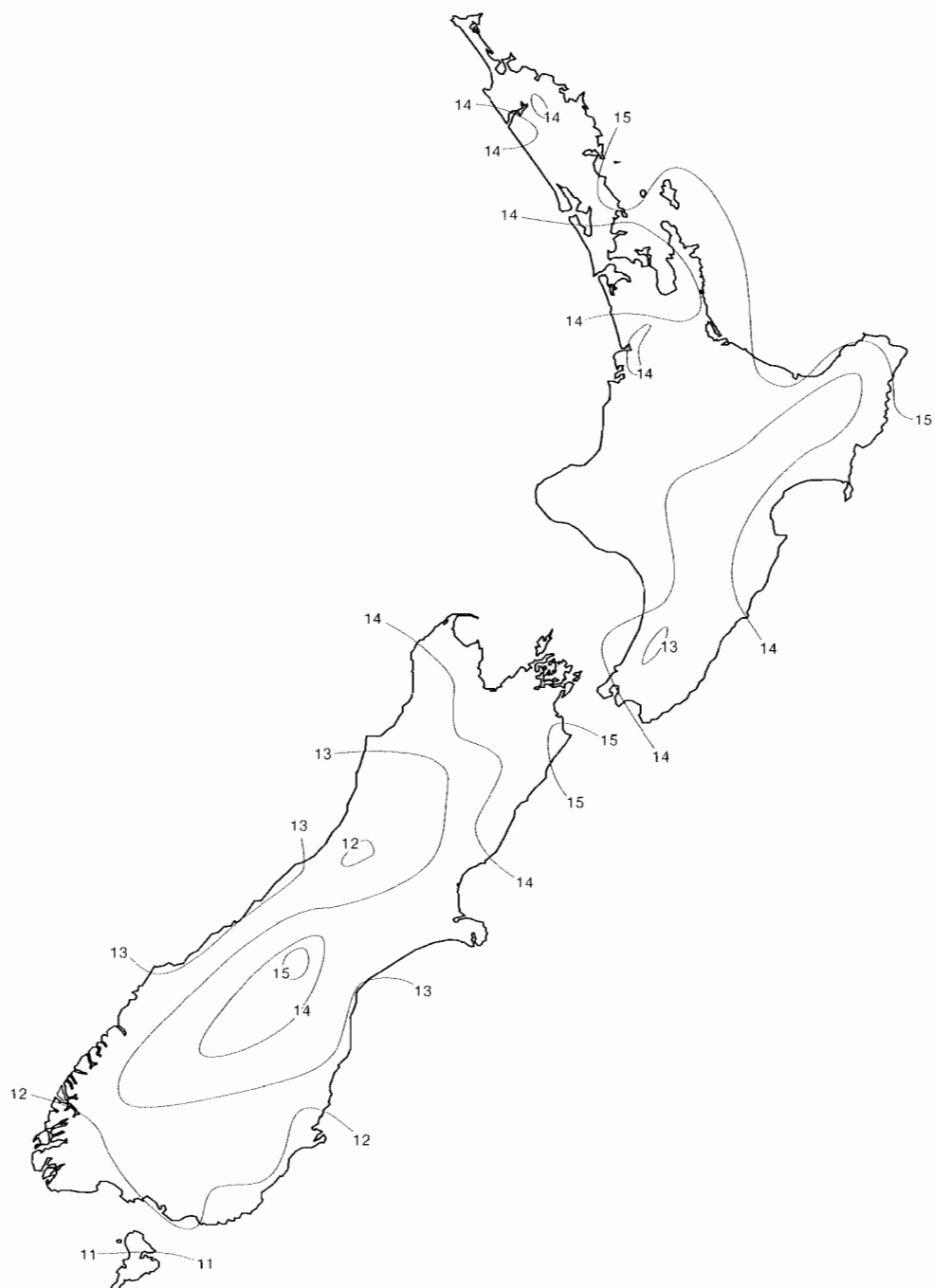


FIGURE H3 CONTOURS OF ANNUAL MEAN DAILY SOLAR RADIATION ON A HORIZONTAL SURFACE (MJ/m².d)

APPENDIX 1

ESTIMATION OF SHADING OF COLLECTORS

(Informative)

11 GENERAL

In order to be able to assess whether or not collectors will be subject to shading during the year, it is necessary to know the solar altitude for the installation location when the sun is at its lowest, i.e., in mid-winter. As most of the useful solar radiation is received within 3 h either side of solar noon for any system installed at or near the recommended orientation and inclination, any significant shading of collectors in these hours, i.e., 9.00 a.m. to 3.00 p.m. standard time, will affect the performance of such a system, and should be avoided in locating the unit. Table 11 lists the solar altitude at midwinter for various locations in Australia and New Zealand. By checking the solar altitude, as observed at the lower edge of the collectors, the installer can determine whether or not nearby buildings, trees or other obstructions will cast a shadow on the collector. For example, if a building, observed from the base of the collectors, is above the midwinter solar altitude, then that building will cast a shadow on the collectors.

TABLE 11
SOLAR ALTITUDE AT MIDWINTER

City	Latitude, degrees	Solar altitude, degrees		
		9.00 a.m.	Noon	3.00 p.m.
Darwin	12	33.5	54.5	33.5
Brisbane	27	23.4	39.5	23.4
Perth	32	19.8	34.5	19.8
Sydney	34	18.3	32.5	18.3
Adelaide/Canberra	35	17.6	31.5	17.6
Auckland	37	16.1	29.5	16.1
Melbourne	38	15.4	28.5	15.4
Devonport	41	13.2	25.6	13.7
Wellington	41	13.2	25.5	13.2
Hobart	43	11.7	23.6	11.7
Christchurch	43.5	11.2	23.0	11.2
Invercargill	46	9.0	20.0	9.0

12 SUN LOCATER

The midwinter solar altitude may be checked using a commercial 'sun locator'; however, a simple solar altitude sight may be constructed from the diagram in Figure 11 for Australia and Figure 12 for New Zealand. The diagram may be glued to cardboard, or preferably reproduced to a larger scale on cardboard, and then cut out and assembled. An assembled sight is shown in Figure 13.

The solar altitude sight is used by aligning the arrow due north, using a compass or map, and with the base of the sight horizontal, sighting the 9.00 a.m., noon and 3.00 p.m. positions of the winter sun, from a viewpoint near the base of the solar collectors. Any objects that can be seen above the sight will cast a shadow on the collector in winter. The use of the solar altitude sight is shown in Figure 13.

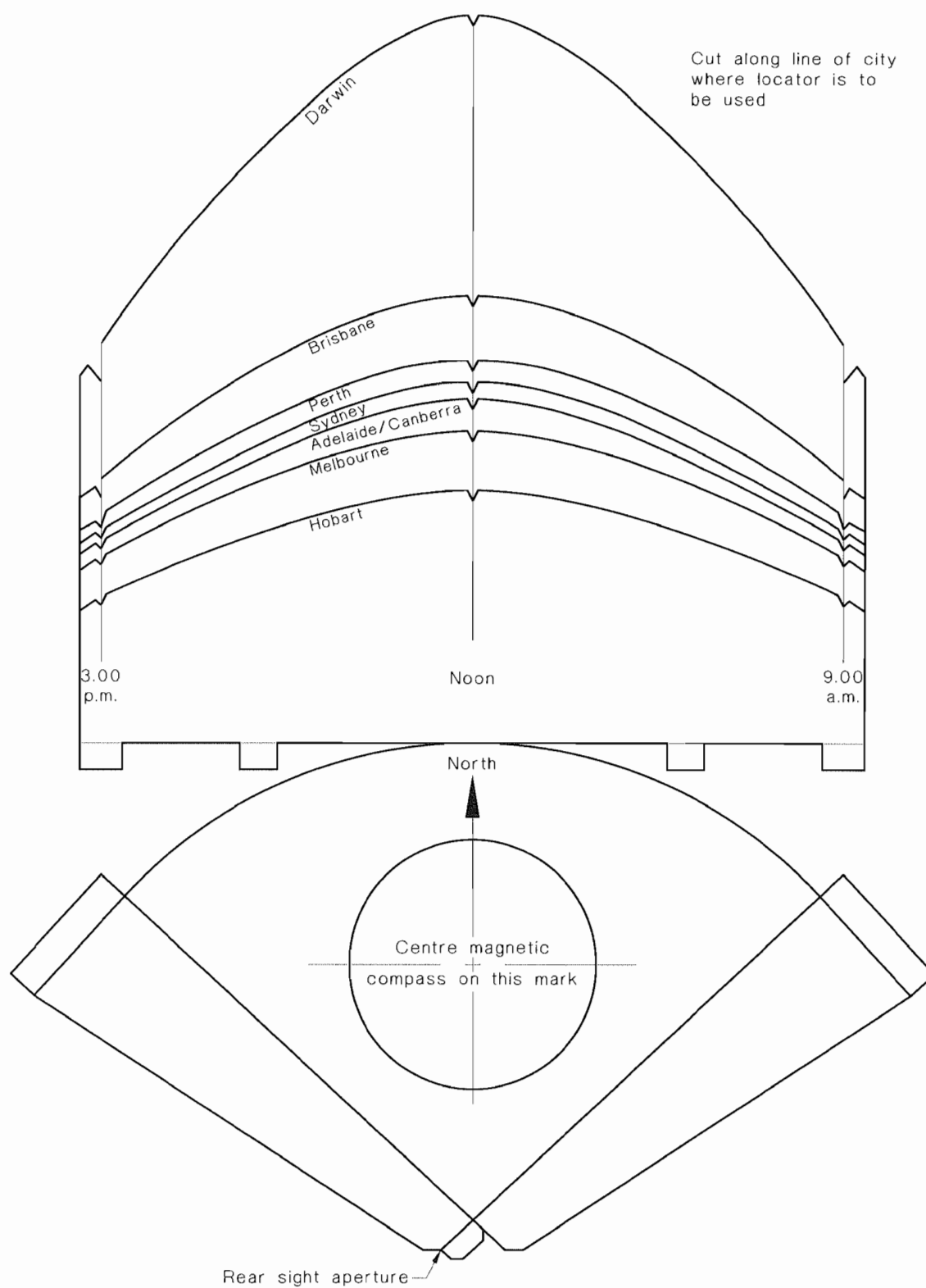


FIGURE 11 MID-WINTER SOLAR ALTITUDE SIGHT (AUSTRALIA)

Cut along appropriate latitude line

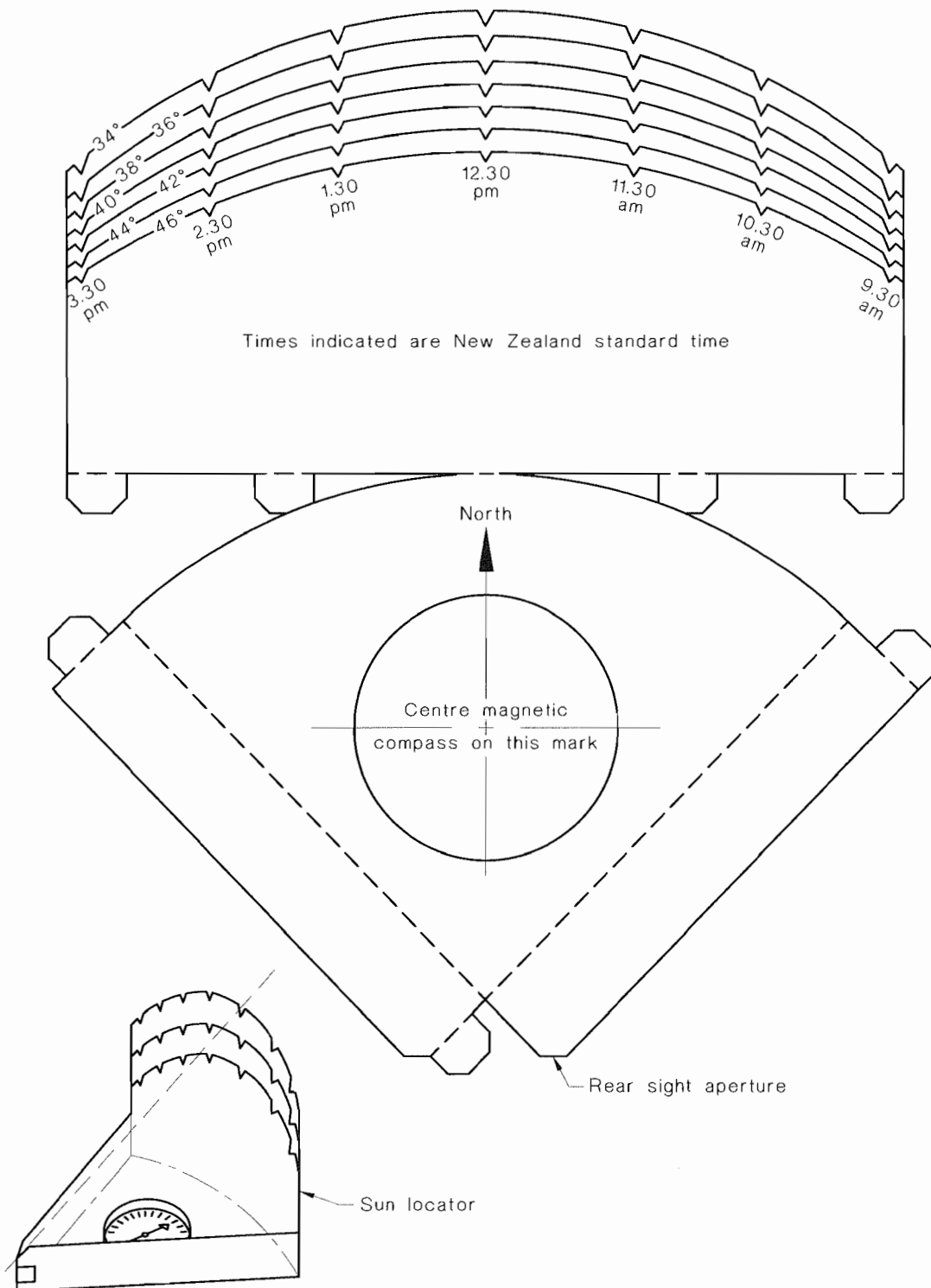


FIGURE 12 MID-WINTER SOLAR ALTITUDE SIGHT (NEW ZEALAND)

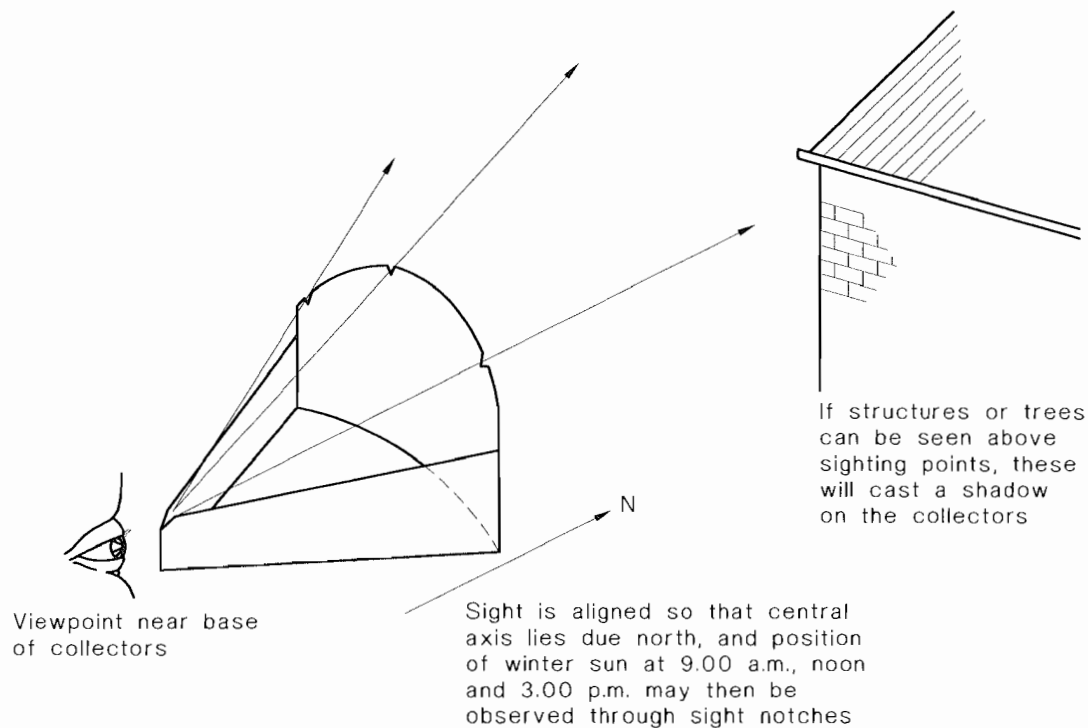


FIGURE I3 USE OF SOLAR ALTITUDE SIGHT

I3 APPROXIMATE METHOD OF DETERMINING SOLAR ALTITUDE

In the absence of a solar altitude sight, the midwinter solar altitude can be estimated by eye, using the fact that a closed fist extended at arm's length from the head subtends approximately 10° at the eye (see Figure I4), as follows:

- (a) Select a viewpoint close to the lower edge of the collectors, and face due north.
- (b) Extend one arm with the index finger in line between your eye and the true horizon.
- (c) Make a closed fist with your other hand, place it upright on top of the extended index finger; this gives a solar altitude of 10° .
- (d) Place the second fist on top of the first, which gives 20° , and so on. Then, using Table II, estimate the altitude of the noon sun in midwinter and note any likely shading.
- (e) Repeat this procedure facing N-E and N-W to estimate the midwinter solar altitude at 9.00 a.m. and 3.00 p.m., respectively, using the data from Table II.

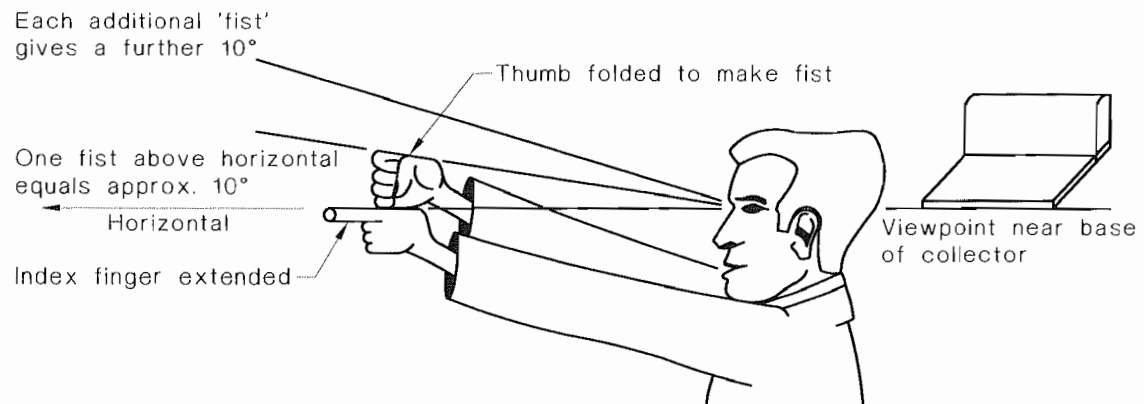


FIGURE 14 'FIST' METHOD OF ESTIMATING SOLAR ALTITUDE

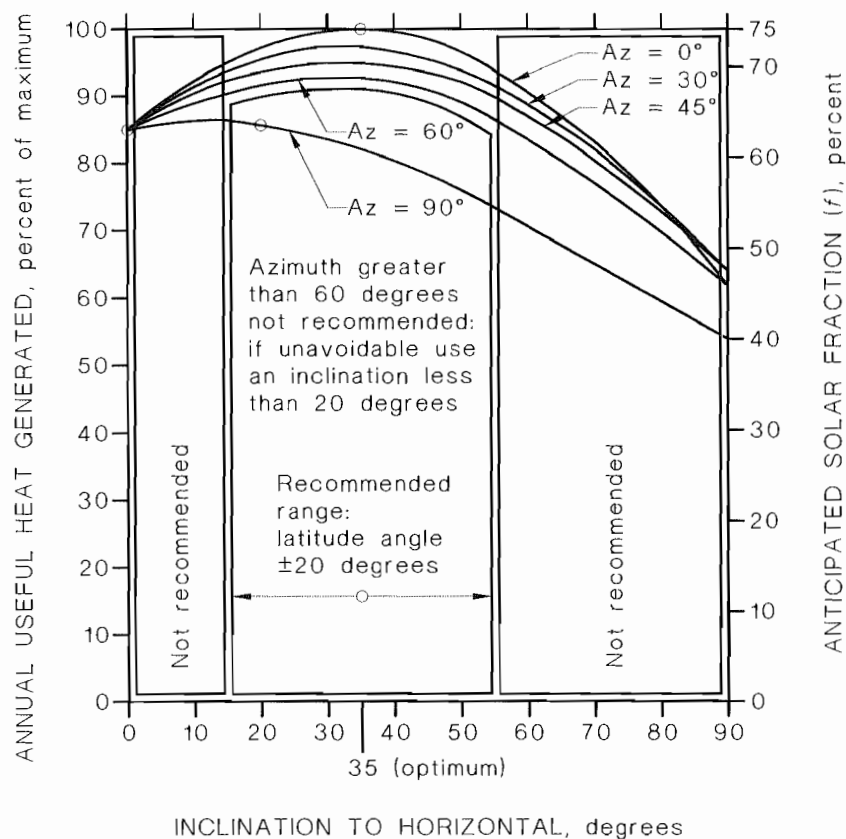
APPENDIX J

EFFECT OF INCLINATION AND ORIENTATION ON SYSTEM PERFORMANCE

(Informative)

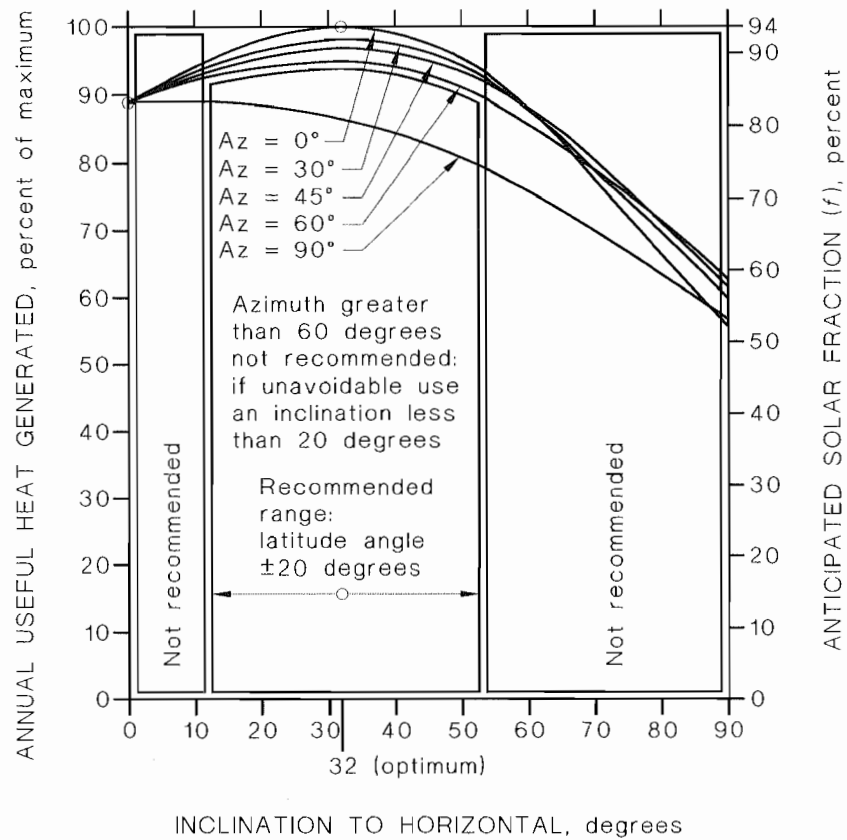
A2 This Appendix provides a series of figures (Figures J1 to J9 for Australia, and J10 to J13 for New Zealand) showing the effect on system performance of variations in collector inclinations for different orientations of the collector. The graphs were plotted using data generated by the 'Sunbear' solar simulation program with radiation data appropriate for each area.

Figures are provided for a variety of locations, and relate to the suggested component sizes for those locations given in Table H1.



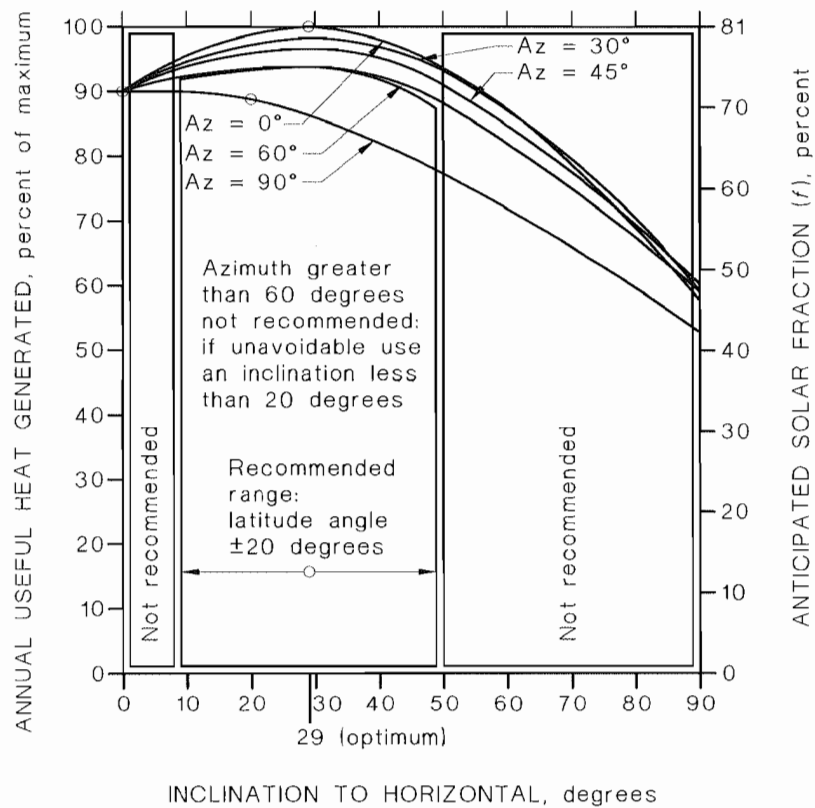
The curves are indicative for the coastal areas of eastern South Australia

FIGURE J1 ADELAIDE—LATITUDE 35°S



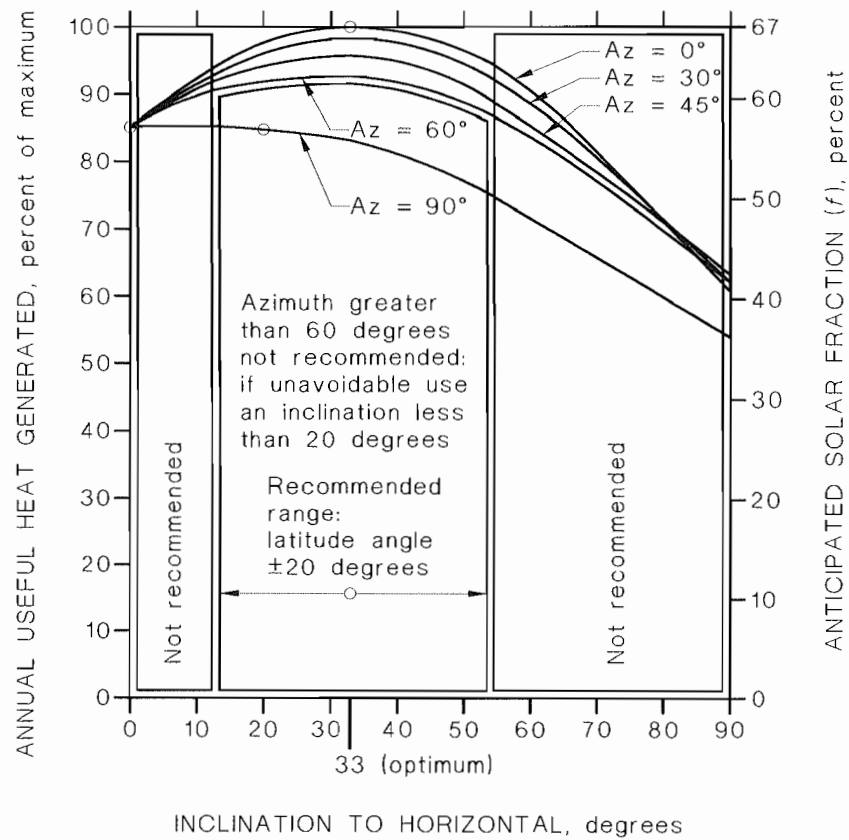
The curves are indicative for the inland areas of central Australia

FIGURE J2 ALICE SPRINGS—LATITUDE 24°S



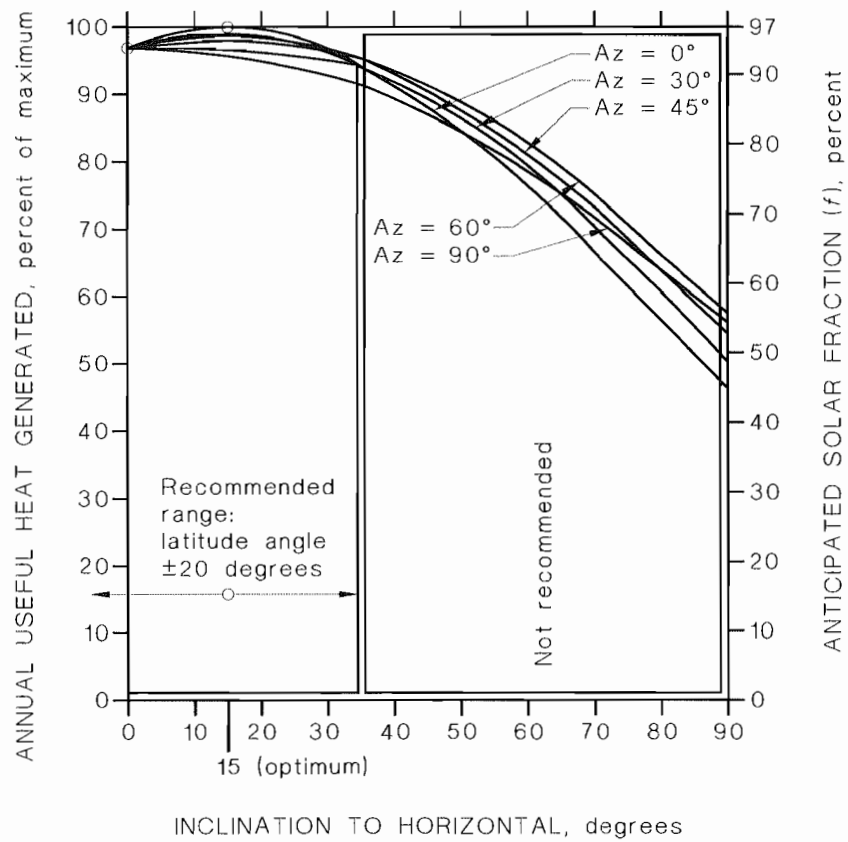
The curves are indicative for the coastal areas of southern Queensland and northern N.S.W.

FIGURE J3 BRISBANE—LATITUDE 27°S



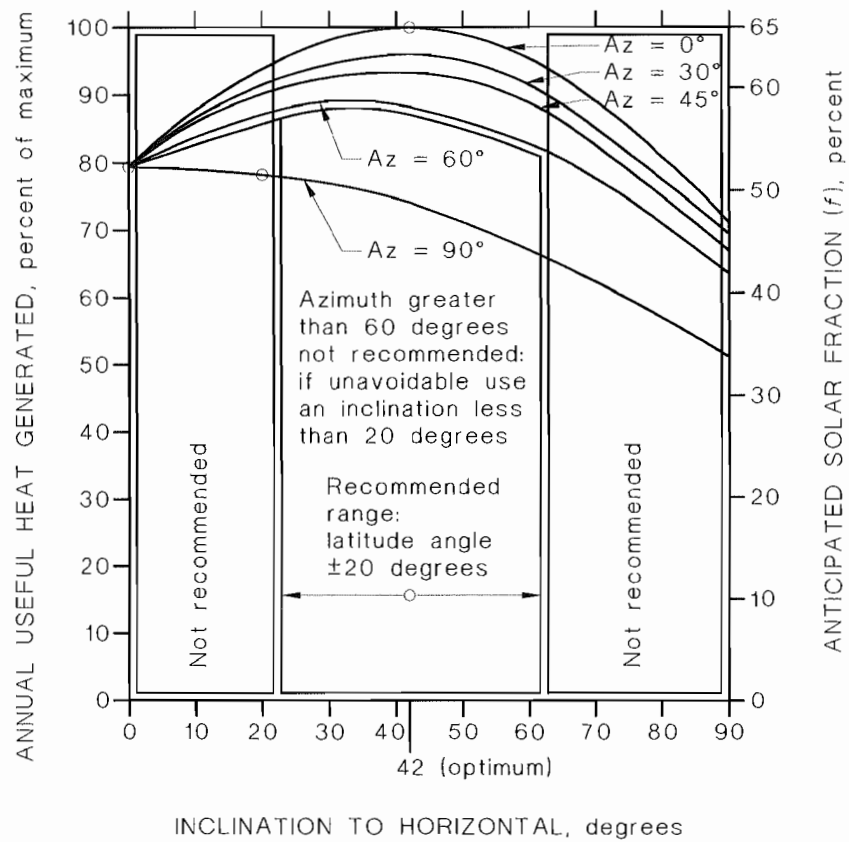
The curves are indicative for the highland areas of N.S.W., A.C.T. and Victoria

FIGURE J4 CANBERRA—LATITUDE 35°S



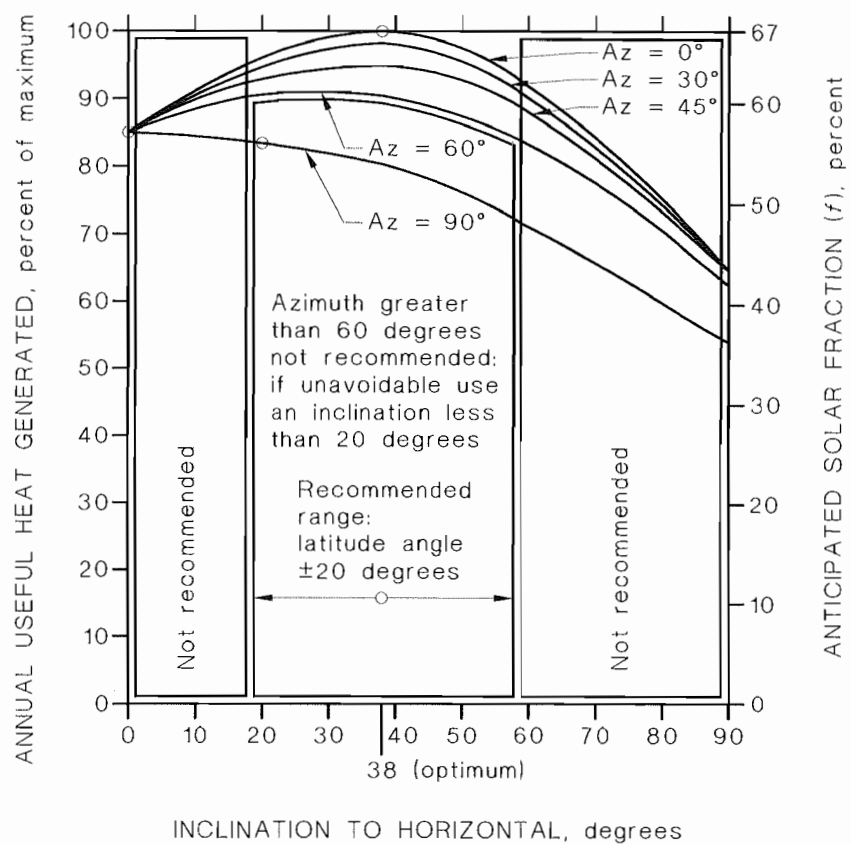
The curves are indicative for the coastal areas of northern (monsoonal) Australia

FIGURE J5 DARWIN—LATITUDE 12°S



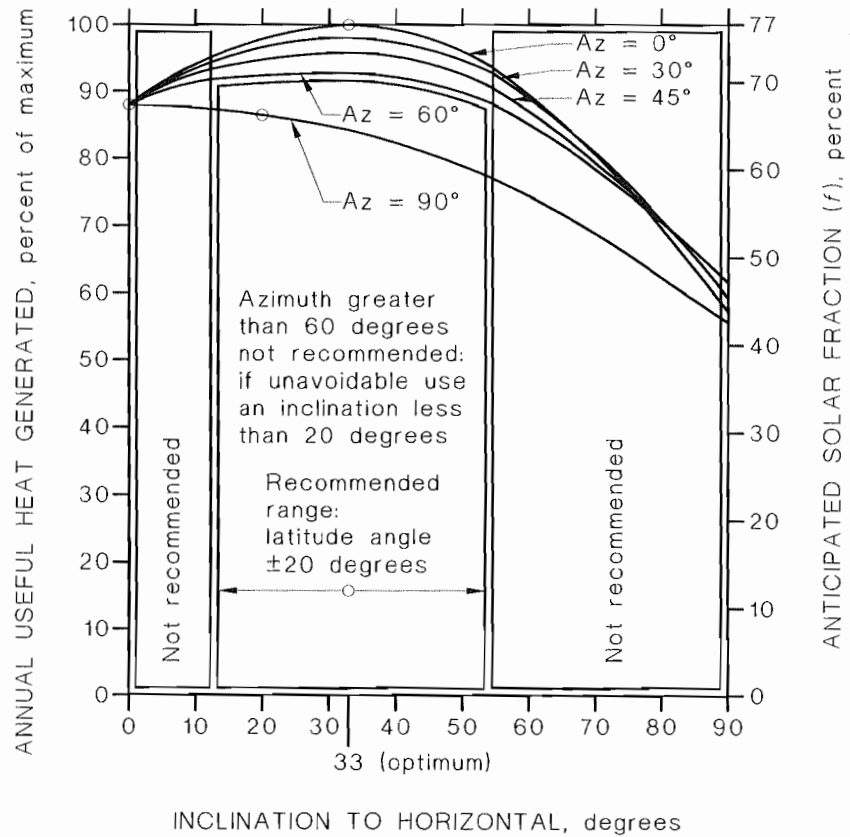
The curves are indicative for the coastal areas of southern Tasmania

FIGURE J6 HOBART—LATITUDE 43°S



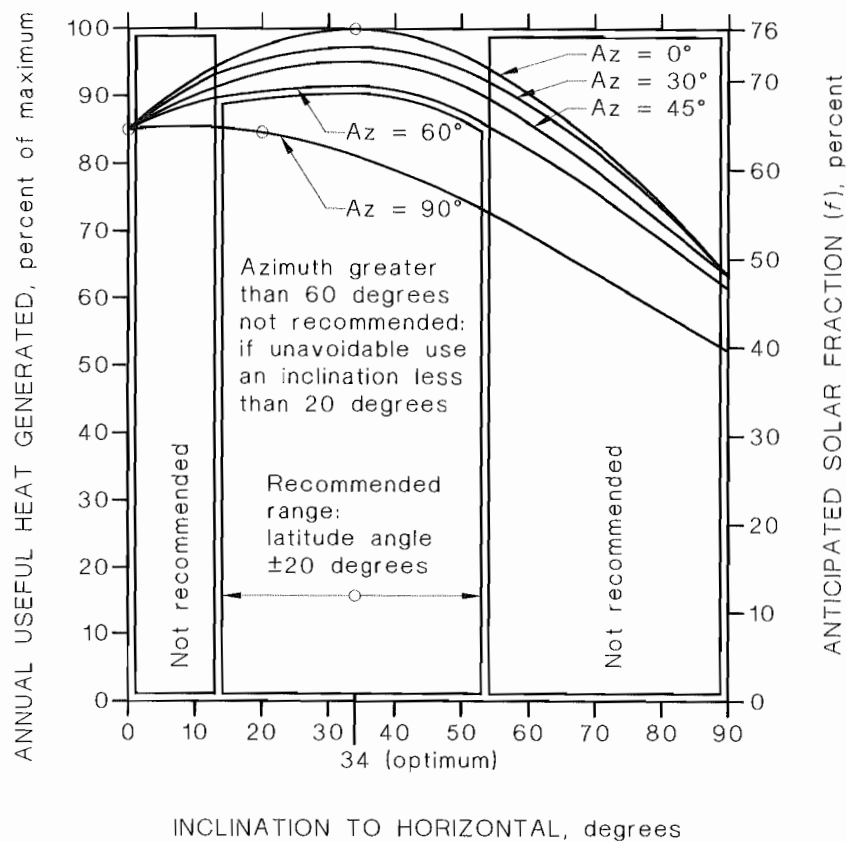
The curves are indicative for the coastal areas of southern Victoria

FIGURE J7 MELBOURNE—LATITUDE 38°S



The curves are indicative for the coastal areas of southern Western Australia

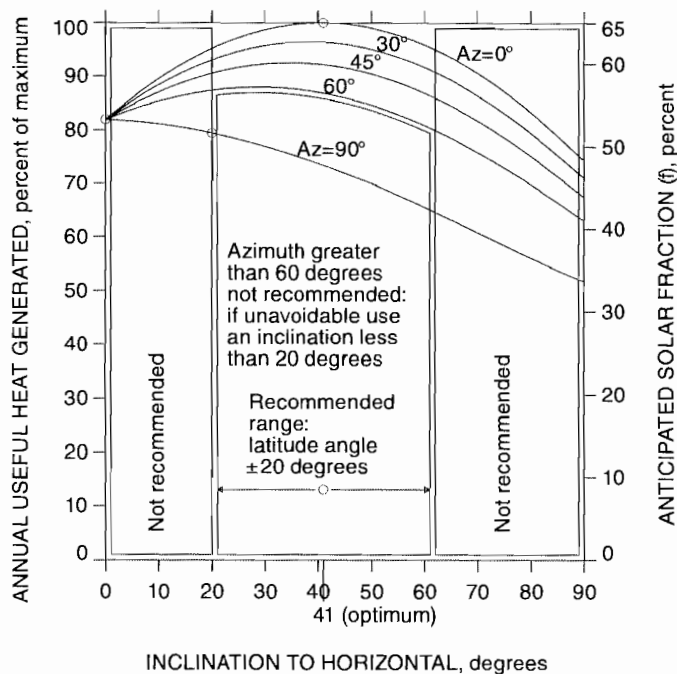
FIGURE J8 PERTH—LATITUDE 32°S



The curves are indicative for the coastal areas of New South Wales

FIGURE J9 SYDNEY—LATITUDE 34°S

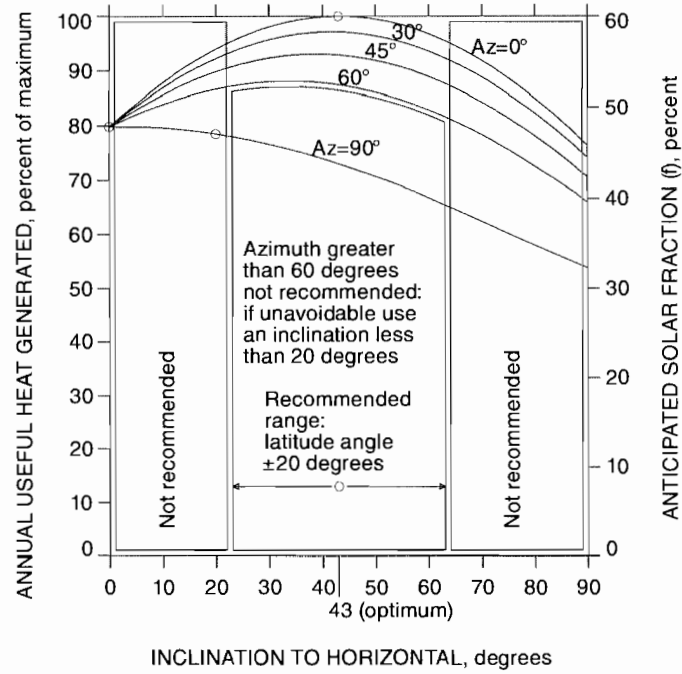
A2



The curves are indicative for coastal areas of the northern North Island

FIGURE J10 AUCKLAND—LATITUDE 37°S

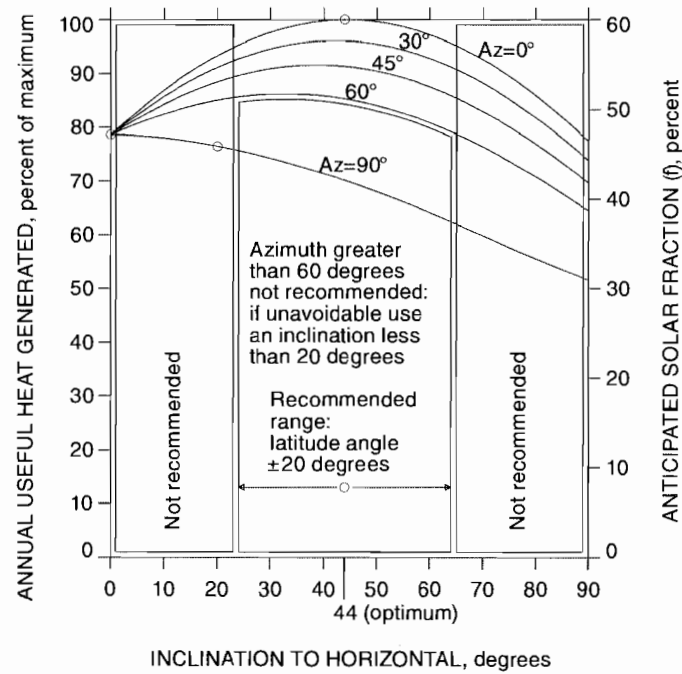
A2



The curves are indicative for coastal areas of the southern North Island

FIGURE J11 WELLINGTON—LATITUDE 41°S

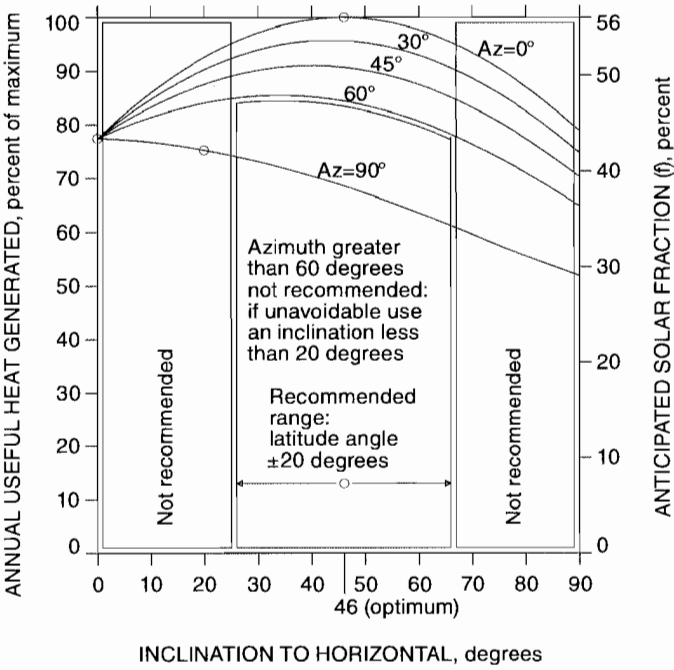
A2



The curves are indicative for coastal areas of the northern South Island

FIGURE J12 CHRISTCHURCH—LATITUDE 43.5°S

A2



The curves are indicative for coastal areas of the southern South Island

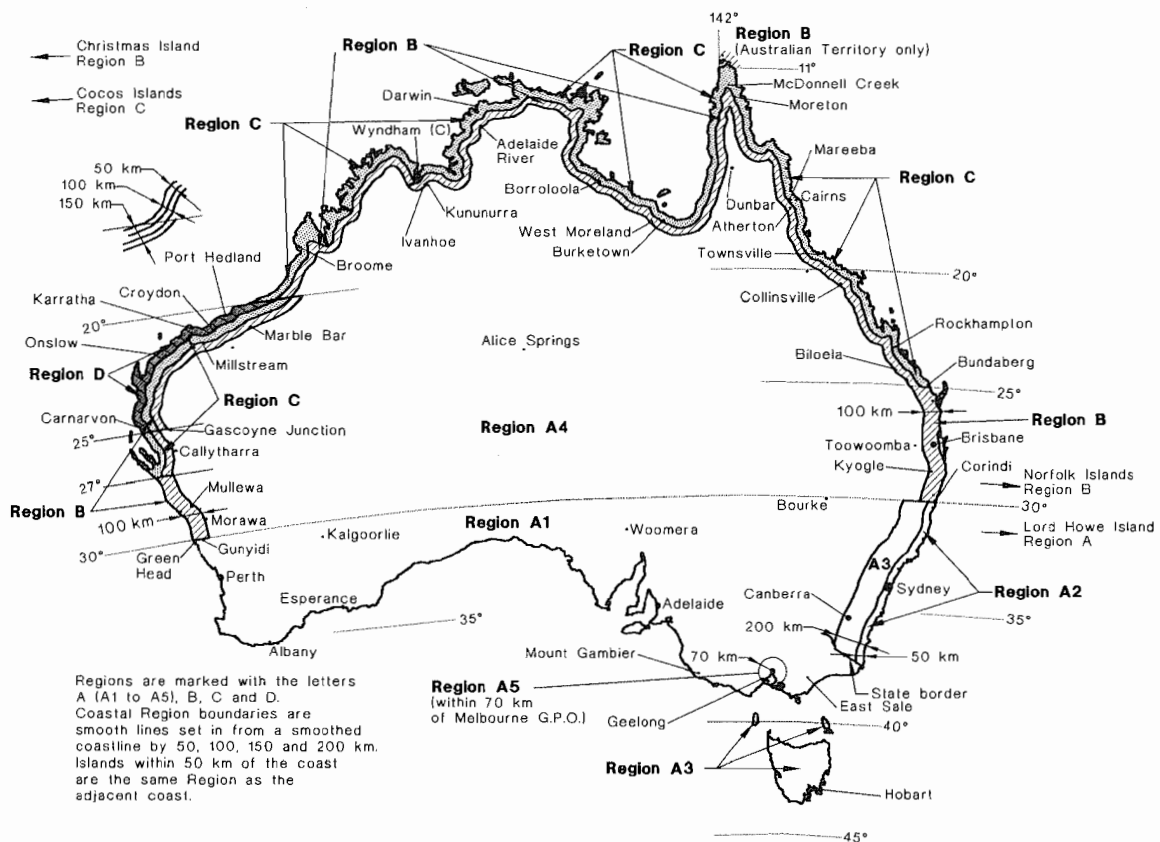
FIGURE J13 DUNEDIN—LATITUDE 45.9°S

APPENDIX K

MAP OF REGIONAL BASIC DESIGN WIND SPEEDS

(Informative)

Figures K1 and K2 are provided as a guide only to the nature of a locality with regard to basic wind speeds. For details of the design of structures to withstand these wind velocities, reference should be made to AS/NZS 1170.2. For details of the design of structures to withstand these wind velocities, reference should be made to AS 1170.2



Regions	Wind velocity, m/s		
	V_s	V_p	V_u
A	38	41	50
B	38	49	60
C	45	57	70
D	50	69	85

FIGURE K1 AUSTRALIA WIND AREAS

A2

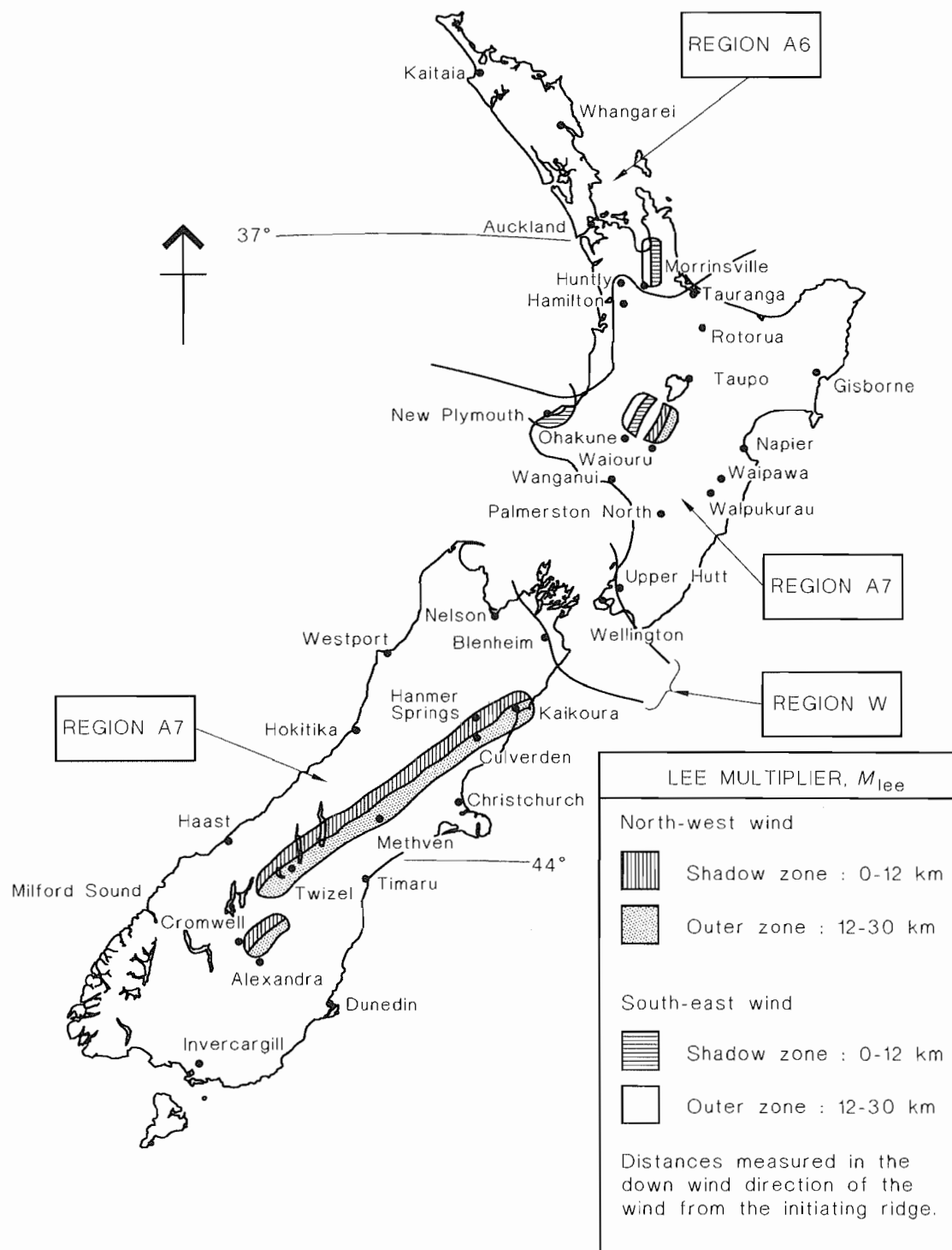


FIGURE K2 NEW ZEALAND WIND AREAS

APPENDIX L
AUSTRALIAN CLIMATE REGIONS
(Normative)

L1 SCOPE

This Appendix sets out the climate regions for Australia as outlined in Figure 8.1 to define the requirements for energy efficiency.

L2 CLIMATE ZONES

The climate region boundaries are based on climatic data in accordance with the climate zones in the BCA (refer Figure 8.1).

Table L1 provides the conversion from the BCA Climate Zones.

TABLE L1
CLIMATE REGIONS AND CLIMATE ZONES

Climate region	BCA Climate zone	Description
A	1	Hot and humid summer warm winter
	2	Warm and humid summer wild winter
	3	Hot and dry summer warm winter
	5	Warm temperate
B	4	Hot and dry summer cool winter
	6	Mild temperate
C	7	Cool temperate
	8	Alpine

TABLE L2
CLIMATE ZONES FOR THERMAL DESIGN—CITY LOCATIONS (BCA)

Town or city	Climate region	Town or city	Climate region	Town or city	Climate region	Town or city	Climate region
Australian Capital Territory							
Canberra	C						
New South Wales							
Albury	B	Byron Bay	A	Ivanhoe	B	Sydney	A
Armidale	B	Cobar	B	Lismore	A	Tamworth	B
Batemans Bay	B	Coffs Harbour	A	Moree	B	Thredbo	C
Bathurst	B	Dubbo	B	Newcastle	A	Wagga Wagga	B
Bega	B	Goulburn	C	Nowra	B	Williamstown	A
Bourke	B	Grafton	A	Orange	C	Wollongong	A
Broken Hill	B	Griffith	B	Port Macquarie	A	Yass	B
Northern Territory							
Alice Springs	A	Elliot	A	Renner Springs	A		
Darwin	A	Katherine	A	Tennant Creek	A		
Queensland							
Birdsville	A	Cunnamulla	A	Maryborough	A	Toowoomba	A
Brisbane	A	Longreach	A	Mount Isa	A	Torrens Creek	A
Bundaberg	A	Gladstone	A	Normanton	A	Townsville	A
Cairns	A	Labrador	A	Rockhampton	A	Warwick	A
Cooktown	A	Mackay	A	Roma	A	Weipa	A

(continued)

TABLE L2 (continued)

Town or city	Climate region	Town or city	Climate region	Town or city	Climate region	Town or city	Climate region
South Australia							
Adelaide	A	Kingscote	B	Mount Gambier	B	Renmark	B
Border Town	B	Leigh Creek	B	Murray Bridge	B	Tarcoola	B
Ceduna	A	Lobethal	B	Oodnadatta	B	Victor Harbour	B
Cook	B	Naracoorte	B	Port Augusta	B	Whyalla	B
Elliston	A	Marree	B	Port Lincoln	A		
Tasmania							
All Tasmania including King Island and Flinders Island					C		
Victoria							
Anglesea	B	Bright	C	Horsham	B	Shepparton	B
Ararat	C	Colac	B	Melbourne	B	Swan Hill	B
Bairnsdale	B	Dandenong	B	Mildura	B	Traralgon	B
Ballarat	C	Echuca	B	Orbost	B	Wangaratta	B
Benalla	B	Geelong	B	Portland	B	Warrnambool	B
Bendigo	B	Hamilton	B	Sale	B	Wodonga	B
Western Australia							
Albany	B	Derby	A	Kalgoorlie-Boulder	B	Perth	A
Balladonia	B	Esperance	A	Karratha	A	Port Hedland	A
Broome	A	Exmouth	A	Meekatharra	B	Wagin	B
Bunbury	A	Geraldton	A	Northam	B	Wyndham	A
Carnarvon	A	Halls Creek	A	Pemberton	B		

APPENDIX M
NEW ZEALAND CLIMATE REGIONS
(Normative)

M1 SCOPE

This Appendix sets out the climate regions for New Zealand, as outlined in Figure 8.2, to define the requirements for energy efficiency.

The climate region boundaries are based on climatic data taking into consideration territorial authority boundaries, providing for 3 regions (see Figure 8.2).

M2 CLIMATE REGIONS

Region A comprises the Coromandel District, Franklin District and all districts north of these.

Region B comprises the remainder of the North Island excluding Taupo District, Ruapehu District and the northern part of the Rangitikei District.

A1 | Region C comprises the remainder of the country, i.e., Taupo District, Ruapehu District, northern part of the Rangitikei District, the South Island and all other islands not in Region A

A2 | **M3 FROST AREAS**

Table M1 shows the frost days throughout regions of New Zealand.

TABLE M1
FROST DAYS

MEAN NUMBER OF DAYS OF GROUND FROST

Data are mean monthly values of the number of days with ground frosts for the 1971—2000 period for locations

Location	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KAITIA	0	0	0	0	0	0	0	0	0	0	0	0	1
WHANGAREI	0	0	0	0	1	3	4	2	1	0	0	0	11
AUCKLAND	0	0	0	0	1	3	4	2	1	0	0	0	10
TAURANGA	0	0	0	1	5	9	12	9	4	2	1	0	42
ROTORUA	0	0	0	2	8	12	14	11	7	3	1	0	57
TAUPO	1	1	1	3	8	12	16	14	9	7	3	1	69
HAMILTON	0	0	1	3	8	11	14	11	7	3	1	0	63
NEW PLYMOUTH	0	0	0	0	1	4	4	3	1	0	0	0	15
MASTERTON	0	0	1	2	8	11	13	12	8	5	2	1	60
GISBORNE	0	0	0	0	3	8	9	8	3	1	0	0	33
NAPIER	0	0	0	0	3	7	7	7	3	1	0	0	29
PALMERSTON NORTH	0	0	0	1	4	8	10	8	4	2	1	0	38
WELLINGTON	0	0	0	0	1	2	3	3	1	0	0	0	10
WANGANUI	0	0	0	0	0	1	3	2	0	0	0	0	7
WESTPORT	0	0	0	0	2	6	8	6	2	0	0	0	26
HOKITIKA	0	0	0	2	5	12	15	12	5	2	1	0	54
MILFORD SOUND	0	0	0	1	7	14	16	13	5	2	1	0	56
NELSON	0	0	1	4	12	18	21	17	10	4	1	0	88
BLenheim	0	0	0	1	6	15	16	13	6	2	0	0	60
KAIKOURA	0	0	0	0	2	6	8	6	4	1	0	0	27
MT COOK	1	1	3	9	19	22	24	23	14	8	3	1	140
CHRISTCHURCH	0	0	0	2	9	16	16	15	9	3	1	0	70
LAKE TEKAPO	1	1	5	11	21	25	27	25	16	9	5	3	149
TIMARU	0	0	2	5	12	21	23	19	12	5	3	0	100
DUNEDIN	0	0	0	2	6	13	16	12	7	3	1	0	58
QUEENSTOWN	0	0	1	5	13	21	24	21	14	7	3	0	107
ALEXANDRA	1	2	3	10	19	26	27	26	19	12	6	2	148
INVERCARGILL	1	2	3	6	9	16	18	16	11	6	4	2	94
CHATHAM ISLAND	0	0	0	0	0	1	1	1	1	0	0	0	4

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AMENDMENT CONTROL SHEET**AS/NZS 3500.4:2003**

Amendment No. 1 (2005)

REVISED TEXT

SUMMARY: This Amendment applies to the Preface, Clauses 1.2.2, 2.3, 2.4.1, 2.4.2, 4.12.1, 4.13.2.1, 5.5.2 and Table 4.7, Sections 8 and 9, and Appendix M.

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REVISED TEXT

SUMMARY: This Amendment applies to the Inside front cover, Preface and Clauses 1.1, 1.3, 1.5, 1.6, 1.9.1, 1.9.2, 1.9.3, 2.2, 2.3, 2.4.1, 2.4.3(c), 2.8.3, 3.3, 4.2, 4.6.1.2, 4.9, 4.12.2, 4.14.9, 5.2.2, 5.3.2, 5.4.1, 5.4.2, 5.5.1(c) (new), 5.5.3(c), 5.6.2(a), 5.8(c)(ii), 5.9.3, 5.12.3, 5.12.5, 6.3.1, 6.3.4, 7.2, 8.1, 8.2, 8.2.1, 8.3.2, 8.4(c), 8.5(b) and 11.4(c)(ii), Tables 5.1 and 8.2, Figure 3.1 and Appendices A, E, F, H, J, K and M and the Bibliography (new).

Published on 10 December 2010.

NOTES

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